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QUESTIONS OF THE OIL-CONTAMINATION OF SOIL-WATER AND AGRICULTURAL SOILS IN THE SOUTHERN PART OF THE HUNGARIAN BASIN

L. Jakucs

It is known that soil-waters are the waters of the strata immediately adjacent to the surface, which are fed from the precipitation falling on the surface and draining away there, and from other surface waters. It is also known that in the feeding of the soil-waters of the Great Hungarian Plain a significant part is played by the living water-courses on the surface: this includes not only the larger streams and rivers, but also the artificially created canal and channel network. In fact, there is a constant flow interaction connection between the surface water network and the soil layers; this may at times be of decisive importance as regards the direction and rate of flow of the soil-waters, their changes in level, and their chemical composition. In periods when the surface waters flood, the river or canal water generally flows from the bed into the conducting soil layers, while at times of low water the beds of the rivers act on the movement of the soil-waters as depression axes.

It is justified, therefore, to assume that the soil-waters can be contaminated by both oil-industry waste waters, for example, and mineral-oil derivatives originating from the various sources. This can occur not only as a result of periodic concentrated infiltrations in the direct vicinity of the discharge, but also throughout the entire length of open-section sewage-carrying channel networks and river beds with low rates of flow, which thus provide only a slight dilution.

Accordingly, in the interest of being able to assess this hypothetical correlation in the concrete regional characteristics of Southern Hungary, we have collected data for the periodic quality control of the soil-waters of the region. Apart from our own examinations, we have also made use of water-analysis data of the VITUKI, the National Geological Institute and the Water-Control Inspectorate of the Lower Tisza Water Board. These latter were restricted to single examinations in the cases of the individual soil-water wells, and thus were of inestimable value primarily in the regional information.

The results of the examinations are summarized in Table 1, Figs. 2—8 (diagrams showing the change in the water quality), and Fig. 1, a sketch-map of the recording positions.

If it is desired to evaluate the results, it must first of all be stated that oil-contamination could not be detected anywhere in the soil-waters, not even in the case of the soil-water test bore in the vicinity of well no. 168 at Algyő, in spite of the fact that unexpected gushing of a well led to more than 20,000 tons of oil pouring onto the surface of the soil, a proportion of this infiltrating.

Naturally, minor discharges and drippings occur everywhere on the oil-producing sites; these fall to the ground and thence enter the channels too. The danger of such

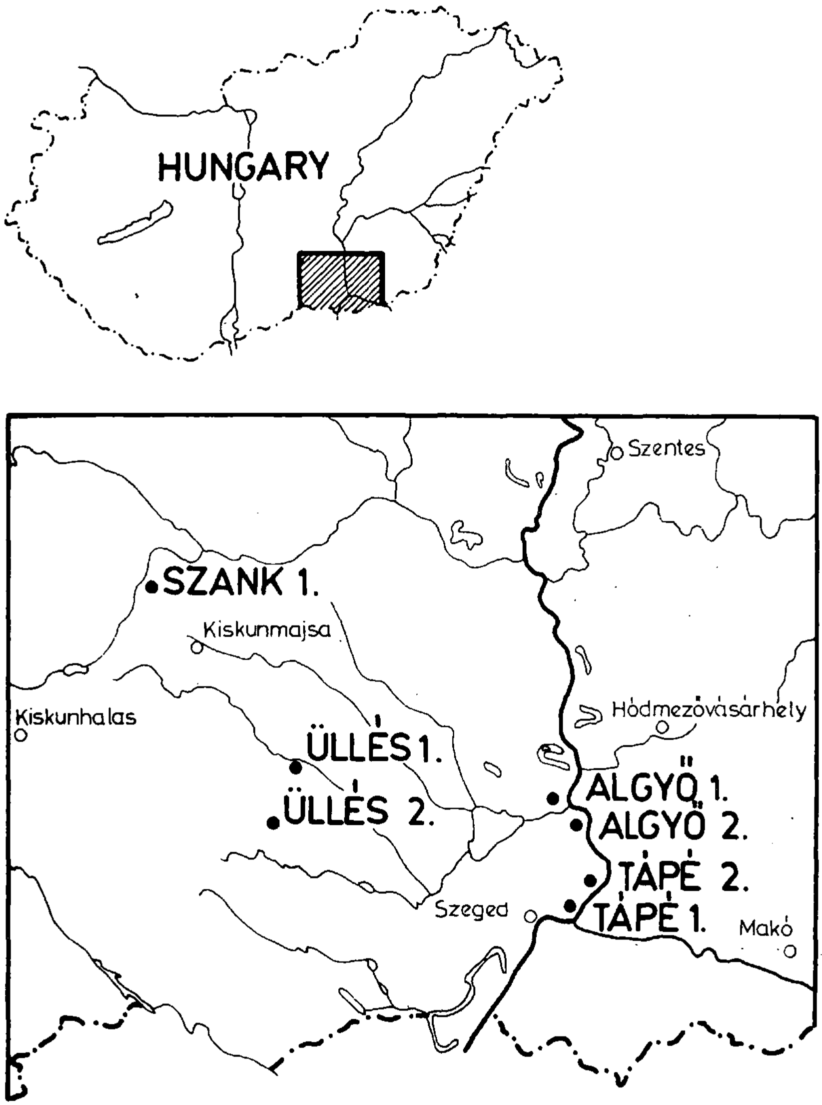


Figure 1. COMPREHENSIVE SKETCH-MAP OF THE SOIL-WATER WELLS ON THE SOUTH HUNGARIAN PLAIN WHICH WERE EXAMINED WITH REGARD TO THE CHANGES IN WATER-COMPOSITION

TABLE 1.

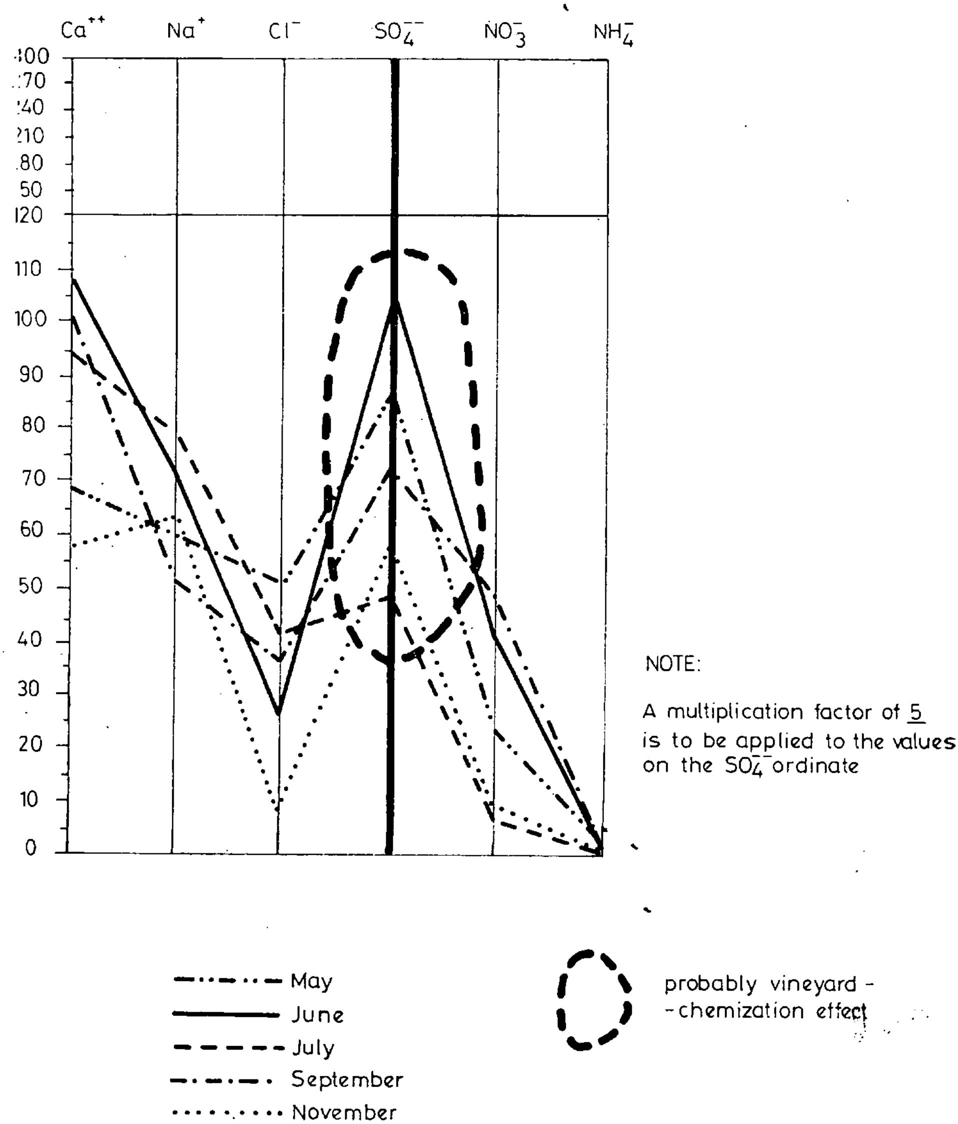
More important constitent characteristics of the chemically-examined soil-water wells of the South Hungarian Plain

(The compilation has been prepared on the basis of the data of the Water-Control Inspectorate of the Lower Tisza Water Board)

Place	Number of wells analyzed	Total hardness			Dissolved salts mg/l			Na as percentage of cations			SO_4 mg/l		
		min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.
Ásotthalom	1	—	—	11,6	—	—	352	—	—	38,4	—	—	35
Battonya	2	32,1	180,3	102,6	1263	7 320	4291	25,6	39,7	32,6	155,6	1294,0	702,3
Balástya	1	—	—	7,7	—	—	1972	—	—	89,6	—	—	26,9
Bordány	1	—	—	15,3	—	—	291	—	—	3,2	—	—	53,0
Csorvás	3	4,1	37,4	19,3	347	1 784	902	36,9	76,3	53,8	44,6	383,6	171,2
Gádoros	17	15,7	51,5	28,0	624	2 459	962	22,2	79,8	28,8	119,5	385,0	191,3
Hódmezővásárhely	24	9,4	140,0	87,0	605	5 418	2764	20,8	67,9	28,7	52,6	1133,0	843,2
Kevermes	4	20,8	47,2	29,9	553	1 162	1044	12,2	57,4	32,0	61,9	351,2	177,7
Kiszombor	1	—	—	46,5	—	—	1574	—	—	27,8	—	—	371,0
Kétegyháza	1	—	—	22,1	—	—	890	—	—	47,8	—	—	17,3
Mezőhegyes	6	26,2	240,8	72,8	933	11 245!	3869	36,6	46,8	42,7	77,6	2810	801,6
Medgyesegyháza	18	14,7	21,2	17,8	461	669	545	10,1	22,9	13,5	19,2	112,2	76,2
Makó	1	—	—	20,2	—	—	1313	—	—	50,0	—	—	203,6
Mórahalom	1	—	—	16,9	—	—	310	—	—	4,5	—	—	17,7
Nagyszénás	7	11,0	61,2	27,4	642	1 340	866	32,0	61,5	50,9	57,2	215,5	109,8
Orosháza	20	9,9	60,4	30,5	552	3 300	2002	23,5	84,8	64,5	19,2	765,0	760,8
Pusztaottlaka	6	7,7	22,7	14,8	344	1 191	782	31,4	84,7	55,8	34,2	121,4	77,5
Pusztamérges	5	22,9	29,5	26,3	495	671	590	5,4	9,5	7,6	43,2	157,5	95,2
Reformátuskovácsháza	2	22,9	59,2	41,0	933	2 846	1699	40,8	53,8	47,3	168,3	662,0	415,1
Szeged	17	19,3	240,0	101,1	620	13 456!	5853	11,7	55,5	33,6	129,9	2840,0	1170,7
Szőreg	2	34,5	162,4	98,5	2044	5 842	3943	29,0	35,7	32,3	165,2	1 880,0	1022,6
Szank	10	13,8	64,9	30,2	300	3 305	1170	6,2	26,3	13,8	61,1	286,0	162,5
Szarvas	1	—	—	38,3	—	—	3916	—	—	48,0	—	—	446,0
Üllés	5	19,3	67,9	44,9	392	2 443	1262	4,9	21,1	13,8	53,0	692,0	293,0

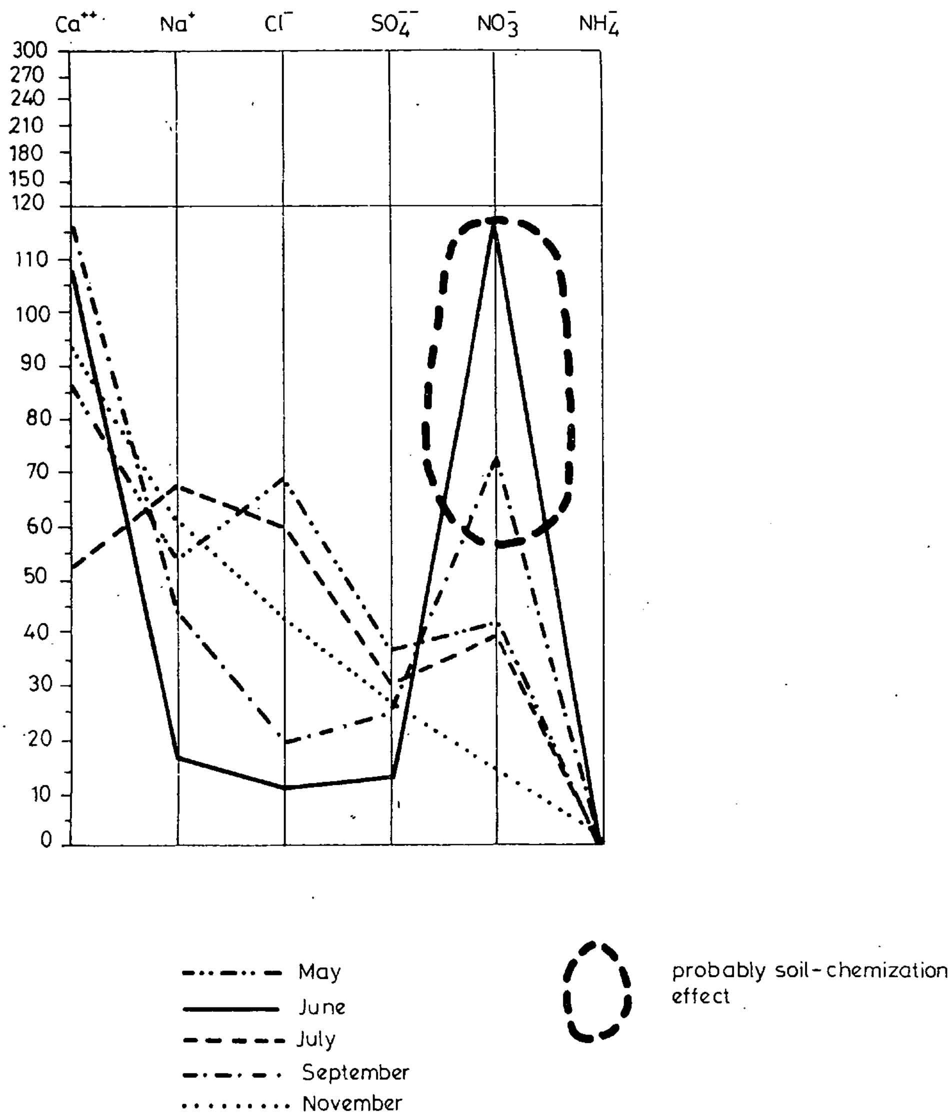
CHANGES IN COMPOSITION OF THE WATER OF SOILWATER WELL NO.1 AT ÜLLÉS

Figure 2.



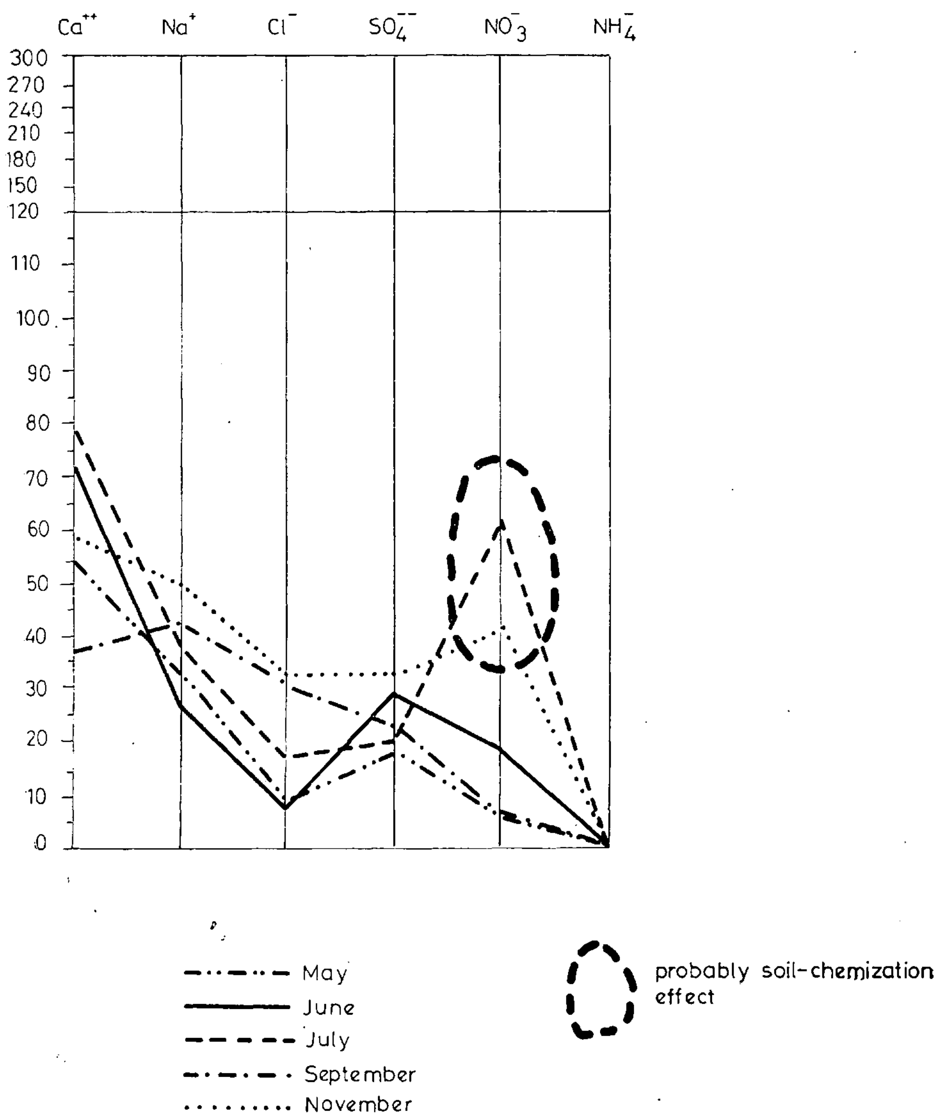
CHANGES IN COMPOSITION OF THE WATER OF SOILWATER WELL NO. 2 AT ÜLLÉS

Figure 3.



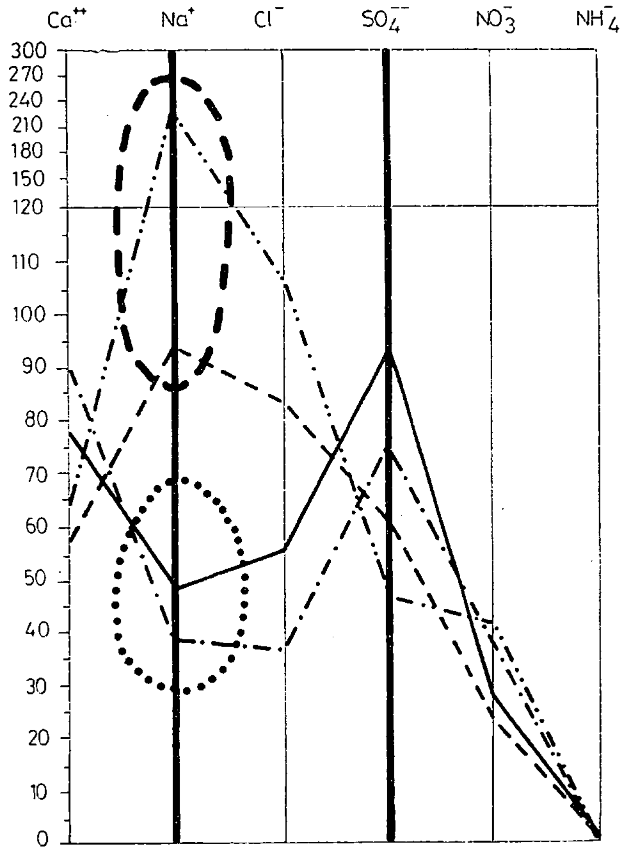
CHANGES IN COMPOSITION OF THE WATER OF SOILWATER WELL NO. 1 AT SZANK

Figure 4.



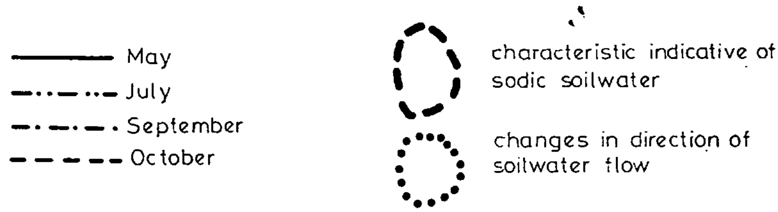
CHANGES IN COMPOSITION OF THE WATER OF SOILWATER WELL NO. 1 AT TÁPÉ

Figure 5.



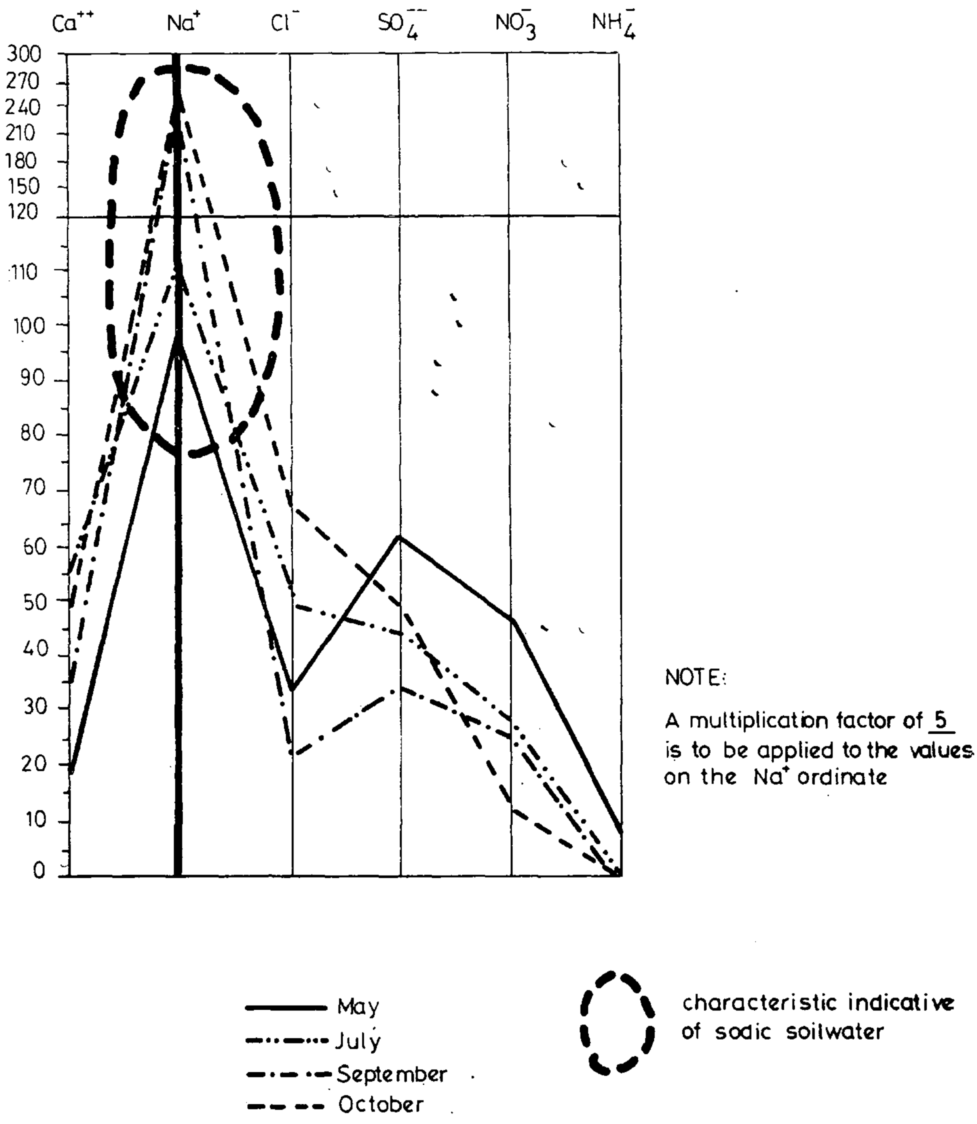
NOTE:

A multiplication factor of 10 is to be applied to the values on the Na^{+} ordinate, and one of 2 to those on the SO_4^{--} ordinate



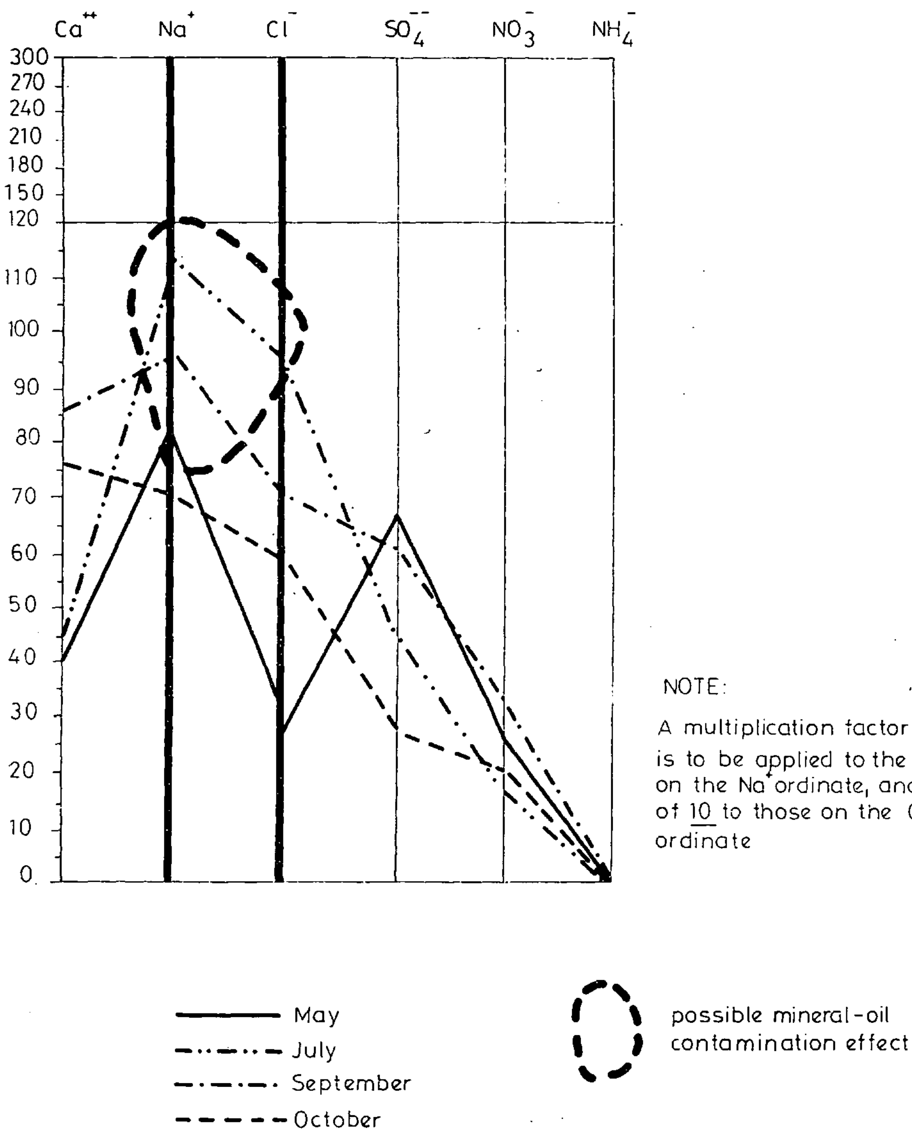
CHANGES IN COMPOSITION OF THE WATER OF SOILWATER WELL NO. 2 AT TÁPÉ

Figure 6.



CHANGES IN COMPOSITION OF THE WATER OF SOILWATER WELL NO. 1 AT ALGYŐ

Figure 7.

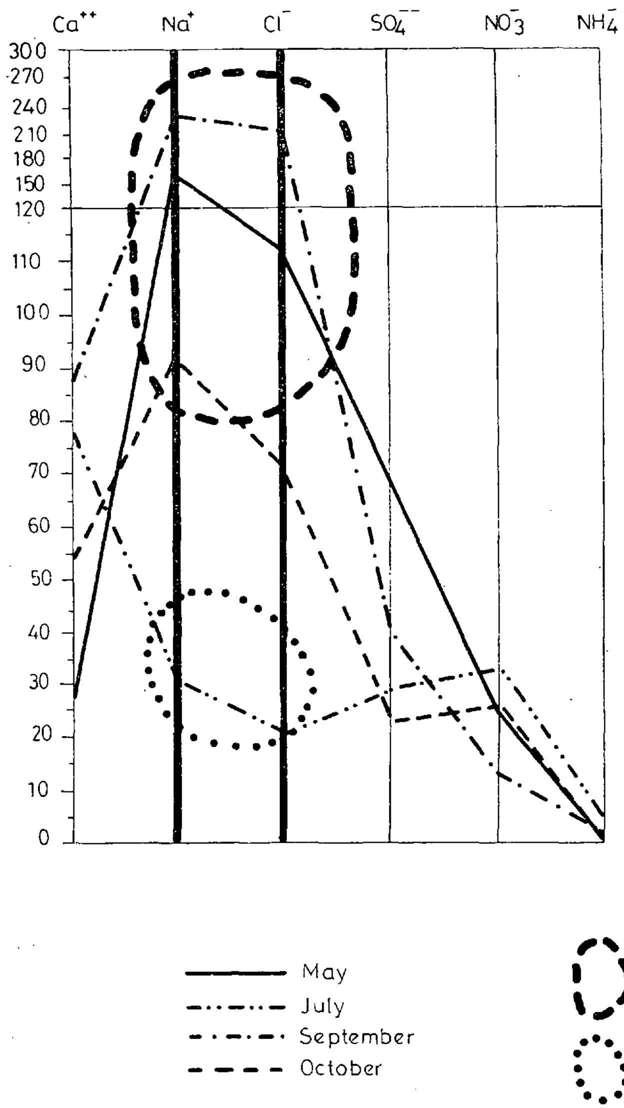


NOTE:

A multiplication factor of 5 is to be applied to the values on the Na^{+} ordinate, and one of 10 to those on the Cl^{-} ordinate

CHANGES IN COMPOSITION OF THE WATER OF SOILWATER WELL NO. 2 AT ALGYÖ

Figure 8.



NOTE:
A multiplication factor of 10 is to be applied to the values on the Na^{+} and Cl^{-} ordinates

inwashing is particularly great on the occasion of more severe summer storms, when oil seepages which have accumulated for even several months may suddenly be washed into the soil by the rain. However, even in these cases our examinations did not disclose the presence of mineral-oil derivatives in the soil-waters.

The cause of the negative results is probably to be found in the fact that even where the soil has a good permeability, it effectively filters out the oil content of the infiltrating water. Thus, the oil either does not reach the soil-water level at all, or if it does, then only after a delay and over a long drawn out period; because of the water exchange within the layers, ensured by the given soil-water flows, this leads to dilution of the oil until it is practically undetectable.

As documented by the results of the soil examinations to be presented below, the oil which infiltrates into the soil (even in the case of sandy soils) adheres so strongly to the surface of the individual mineral particles that it can be detected on them even years later. For just this reason, the composition of water flowing through such a layer is not modified by the oil.

From another aspect, the results permit the conclusion that the running-off of oil-industry waste waters can affect the concentrations of sodium and chloride ions in the soil-waters. In the case of coarse grained sand with a good conducting capacity, the increase of the chloride content of the soil-waters can be detected in the direction of flow of the soil-water, sometimes even at a distance of several kilometres from the site of infiltration of the waste water. However, the observed increase in the NaCl concentration of the soil-water has so far not proved to be of an extent harmful to the water in even a single case. A harmless chemical is involved, and at the dilutions observed the question is rather only of theoretical importance.

The characteristics of the water of the individual soil-water wells as regards chemical composition can not always be interpreted with certainty. Indeed, it is not possible to draw clear-cut conclusions even from the considerable increases in the sodium and chloride ion concentrations, for these uppermost soil-waters react extremely sensitively to many chains of factors which are still not satisfactorily understood; we are in the main still unable to perceive suitable connections between all the effects. As illustrated by the composition-modification diagrams, even at a given well within a short time the quality of the water may change to a very large extent, the difference being similar to that observed earlier between two widely-separated wells. Here we think primarily of the decisive role of the great variational possibilities of the following modifying factors:

1. The variable direction of the soil-water flow, which depends on the regional distribution of the precipitation conditions, on the local magnitudes of the running-off and the output, etc.
2. The regionally different evaporation losses of the soil-water surface, affected by the plant cover, the soil-surface state, etc.
3. Factors affecting the local differences in output of the infiltration supply, varying from time to time (fresh ploughland, stubble, meadow, area of growing crops, etc.).
4. Concrete petrological and mineral-composition features of the main infiltration zone, frequently modified even locally.
5. Not least of all the regionally applied artificial fertilizers, insecticides and other anthropogenous chemization.

Naturally, the variation of by and large these same factors also has the result that synchronously taken water samples from soil-water wells sunk in the immediate vicinity of one another frequently exhibit significant differences. As an illustration of this, we present the following example (see Table 2).

TABLE 2.

Results of water-chemical examinations of two soil-water wells (separated by 60 m) of Kálmán Kabna (Domaszék, Tanya 243)

Component	Unit	Well 1	Well 2
alkalinity	W°	9.6	9.5
total hardness	Gh°	22.6	48.2
calcium	mg/l	45.6	109.1
sodium	mg/l	50.6	51.6
chloride	mg/l	70.9	55.0
sulphate	mg/l	102.0	346.0
total dissolved salt	mg/l	880.0	1110.0
oxygen consumption	mg/l	10.4	9.9
ammonium ion	mg/l	0.6	0.5
nitrate ion	mg/l	25.0	33.3

Overall, therefore, it must be stated that as a result of the spontaneous natural factors and the intensive agrogenous interventions, there are such extreme fluctuations in composition in the soil-waters of the South Hungarian Plain that, in comparison, the effects of possible and local oil contaminations can not be distinguished convincingly, even by means of examinations specifically aiming at this.

The situation is entirely different with oil-contaminations on the various types of soils, for it appears very probable that the hydrocarbons infiltrating into the soil will be detectable for many decades, even in the layers where the concentration of the original contamination was only slight: it is only with extreme difficulty that the high molecular weight hydrocarbons bound to the colloidal soil particles and adhering as a film of molecular thickness to the surface of the individual larger mineral grains are broken down to soil. Our regional examinations have proved that there are sharply delineated changes in the structural properties of the soil and in the various functional characteristics of the soil life, even when it is hardly possible to detect the presence of the hydrocarbon in the soil by the customary physical and chemical examination procedures.

In order to assess the characteristics of a soil zone contaminated with hydrocarbon in comparison with a soil zone of the same composition, but not contaminated, a multichannel control investigation was performed at several points on the South Hungarian Plain in the year following the contamination. Soil from the selected points was subjected to laboratory examination for determination of the carbon, humus and hydrocarbon contents. Measurements of the changes in the soil strength and microclimatological analyses were also carried out on site, in an effort to establish the lasting modifications in the biofunctions and dynamics of the soil.

The results are reported below.

The main areas of our examinations were the following:

1. environment of bore no. 1 at Tápé;
2. environment of bore no. 4 at Üllés; and
3. environment of bore no. 4 at Szank.

Apart from these complex station environments, however, further examinations were also made in the regions of Algyő and Kardoskút.

Soil-genetic maps of the complex station environments are given in Figs. 9—11, on the basis of the data of Géczy.

Low-depth drillings were bored in all three test environments, and with the aid of these examinations were made of those components of the various soil levels from which conclusions can be drawn as to the present extent of the hydrocarbon contamination. The positions of the soil-analysis drillings bored in the environment of well no. 1 at Tápé are shown in Fig. 12, together with the results of the laboratory measurements. Figures 13 and 14 show the corresponding data from the environments of bore no. 4 at Üllés and bore no. 4 at Szank, respectively.

Microclimate stations too, recording soil and air temperatures, were established by M. Andó in the South Hungarian Plain sampling areas selected for study, and these were used to record a full series of temperatures, at hourly intervals, on a hot summer day. His results proved very interesting, for they were very characteristic, even at those points where the soil had been contaminated with only a small amount of hydrocarbons, and years earlier.

From a study of the thermal-conductance heating-up properties of levels with different soil-depths, in practically every characteristic soil type occurring in this region, it emerged everywhere that *the thermal conductivity of soils contaminated at some time with oil had deteriorated substantially*. Consequently, the upper soil layers (those exposed directly to irradiation) heat up very strongly, but at the same time they are able to transmit this amount of heat to the deeper levels only in part, and even then only with a certain delay.

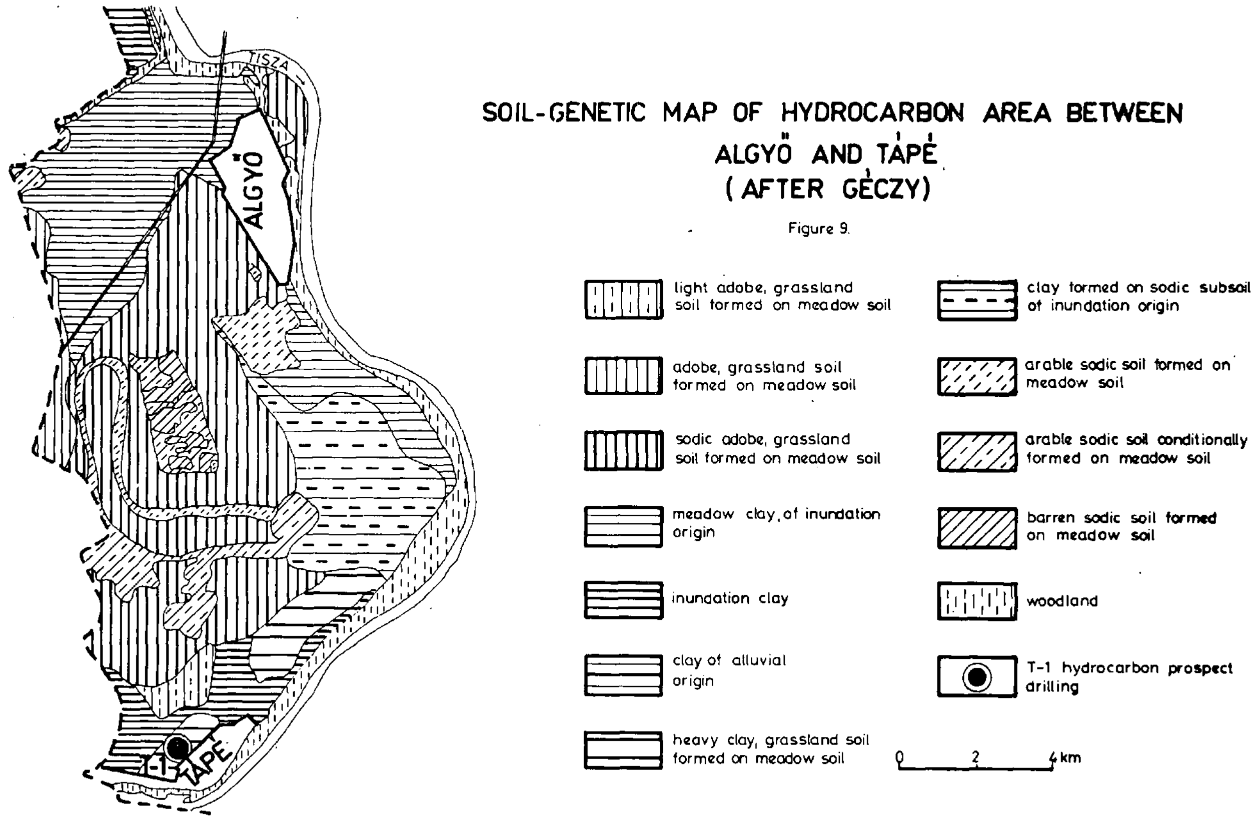
In every other case too there is a phase delay in the heat transfer towards the deeper layers, this being in proportion to the thermal-conductance capacity of the rock-material of the layer. In soils contaminated with hydrocarbon, however, independently of the petrological facies of the soil, this delay increases considerably. These characteristics are well demonstrated by the daily temperature curves recorded on the sodic muddy soil in the region of Algyő (see Figs. 15 and 16), but essentially the same is observed at the other stations too.

Figures 17 and 18 present the observations from the station on meadow clay at Algyő. Here the poor thermal conductivity of the contaminated soil appears even more markedly for the individual soil levels (2, 5, 10, 20 and 30 cm). Whereas the phase delay between the daily temperature maxima of the uppermost and the 30 cm soil levels is only 5 hours in the uncontaminated soil, in the oil-contaminated clay soil the corresponding value is 14 hours.

The effect of contamination on the thermal household of the soil was examined on the muddy loess soil in the region of Kardoskút. In this case too the overall result agreed with those from the stations in the region of Algyő. Since the air temperature too was measured at different levels here, however, the data are plotted in the form of isopletes (see Figs. 19 and 20). In these temperature curves it can also be seen that the radiation reflection heating-up characteristics of the air are likewise affected by the oily contamination of the material of the soil, in so far as

SOIL-GENETIC MAP OF HYDROCARBON AREA BETWEEN ALGYŐ AND TÁPÉ (AFTER GÉCZY)

Figure 9.



SOIL-GENETIC MAP OF ENVIRONMENT OF HYDROCARBON PROSPECT DRILLINGS NOS. 3 AND 4 AT ÜLLÉS (AFTER GÉCZY)

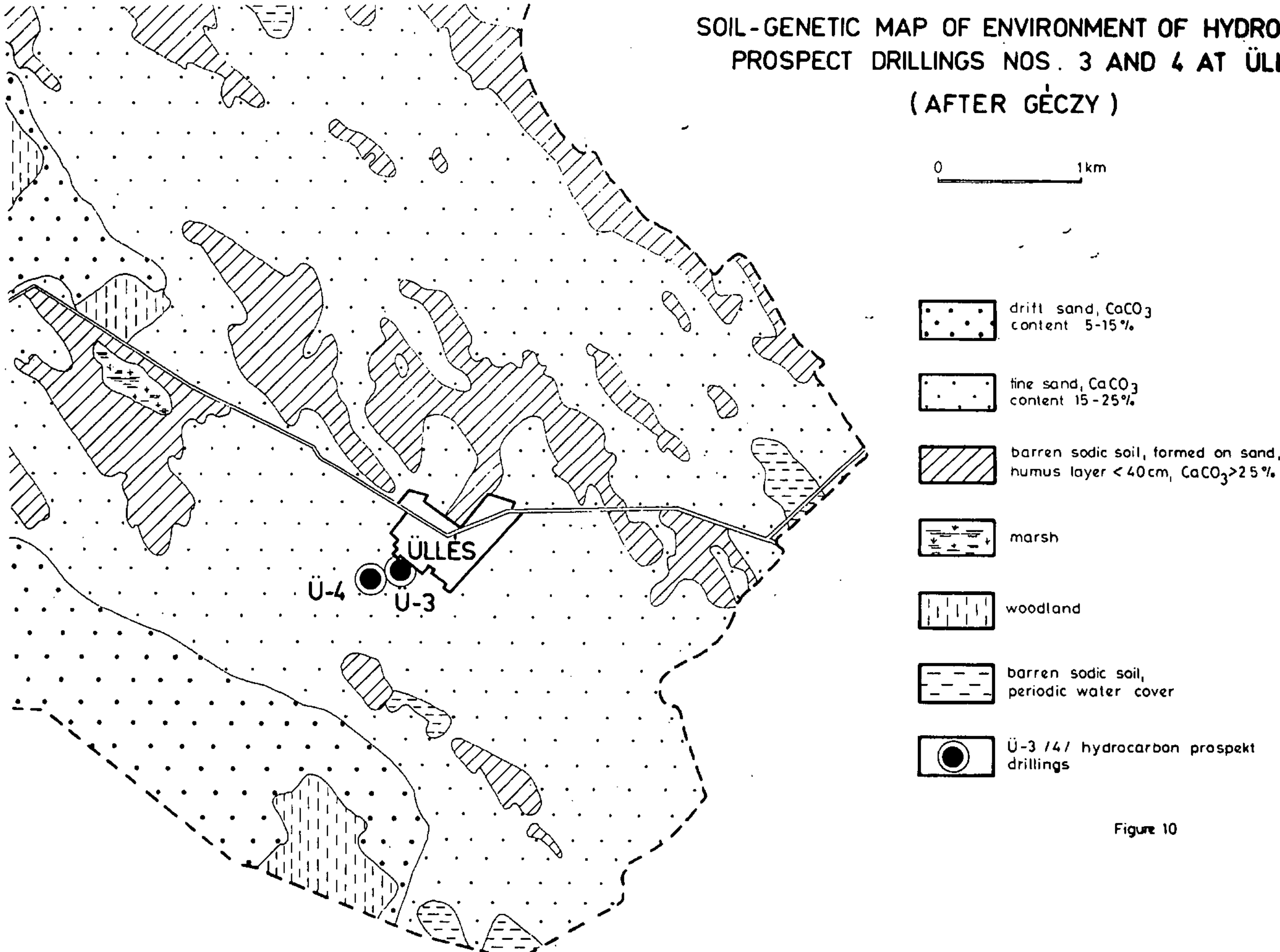


Figure 10

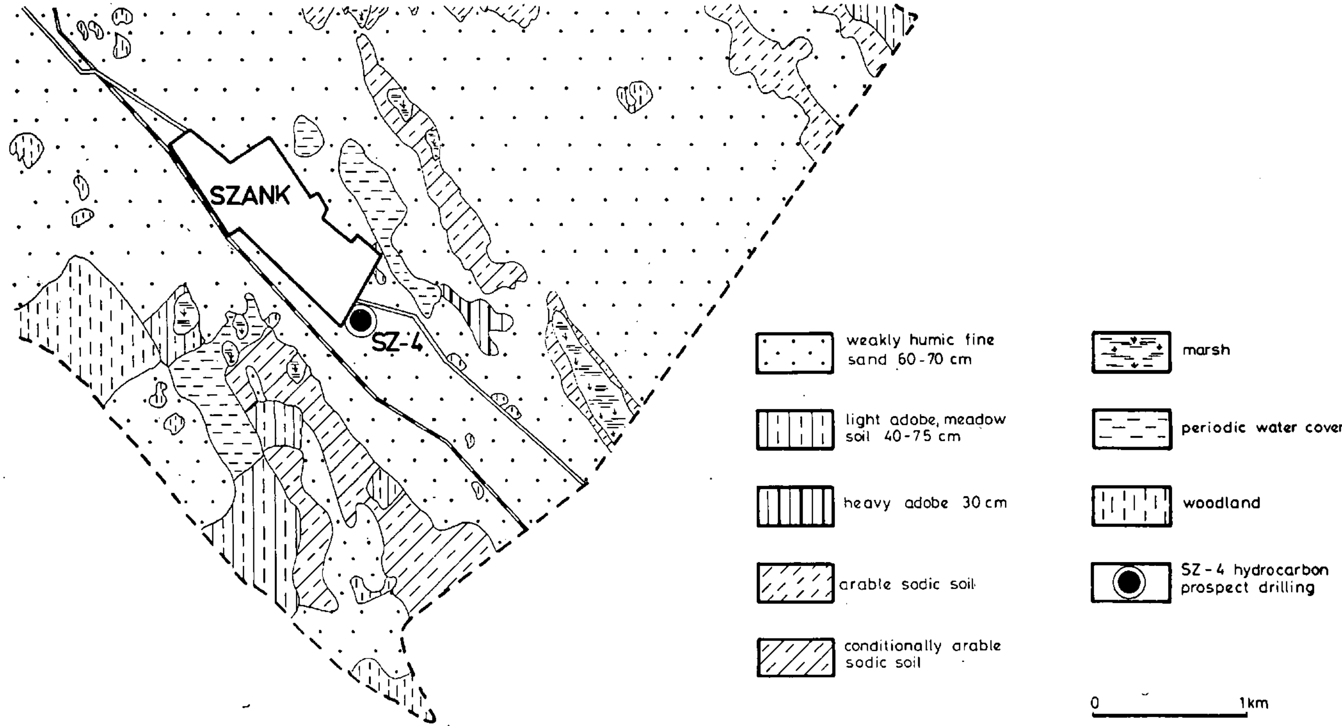
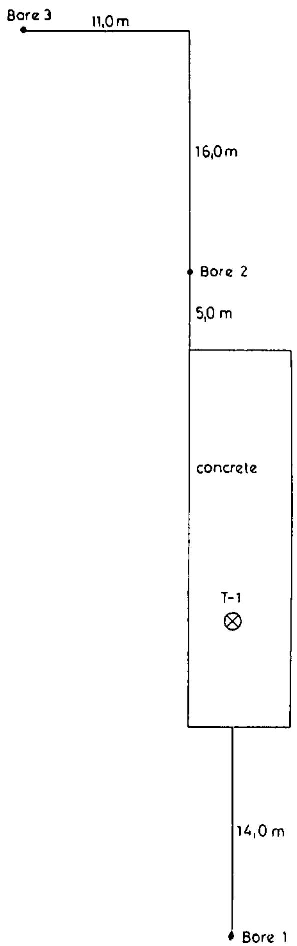


Figure 11.

SOIL-GENETIC MAP OF ENVIRONMENT OF HYDROCARBON PROSPECT DRILLING NO. 4 AT SZANK (AFTER-GÉCZY)

SITE - PLAN



Layer sequence of bore 1		SAMPLE depth	symbol	carbon content %	humus content %	hydrocarb. content %
brownish humic	- blak clay	-0,20	T-1/1	1,63	2,82	much
0,40						
yellowish humic 0,55	brown clay	-0,45	T-1/2	1,27	2,00	Ø
yellow	mud	-0,60	T-1/3	0,48	0,83	Ø
	(0,80)					

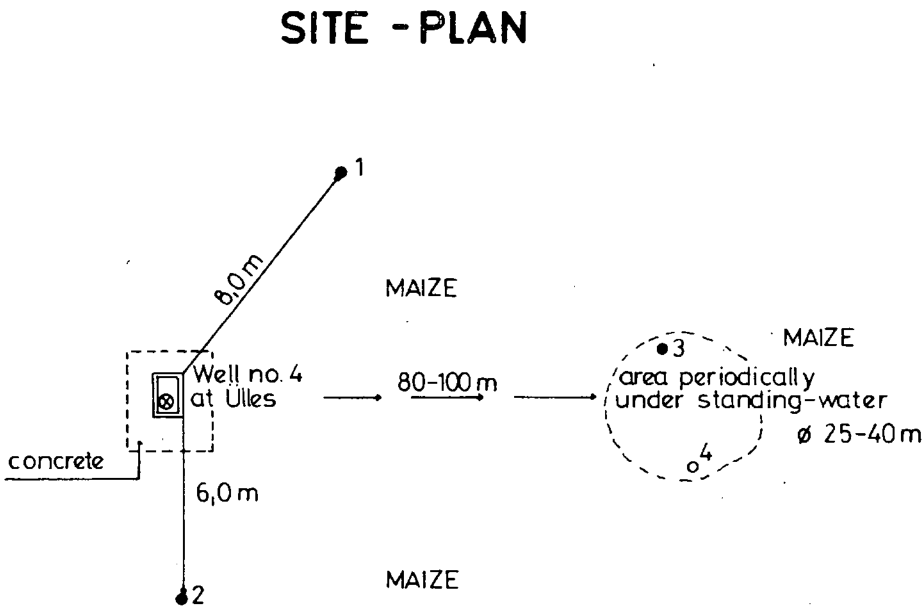
Layer sequence of bore 3		SAMPLE depth	symbol	carbon content %	humus content %	hydrocarb. content %
brown	humic clay	-0,20	T-3/1	0,98	1,68	Ø
0,35						
brownish 0,45	yellow clay	-0 40	T-3/2	0,63	1,08	Ø
yellow	mud	-0,55	T-3/3	0,48	0,83	present
	(0,80)					

Layer sequence of bore 2		SAMPLE depth	symbol	carbon content %	humus content %	hydrocarb. content %
brownish humic	black clay	-0,20	T-2/1	1,59	2,76	very much
0,25						
yellow	clay	-0,35	T-2/2	1,28	2,21	much
0,50						
yellow	mud	-0,55	T-2/3	0,42	0,73	present
	(0,80)					

0 5 10 m

Figure 12.

Humus and hydrocarbon contents of soil samples taken form area of infiltration of hydrocarbons from water prospect drilling no. 1 at Tápé

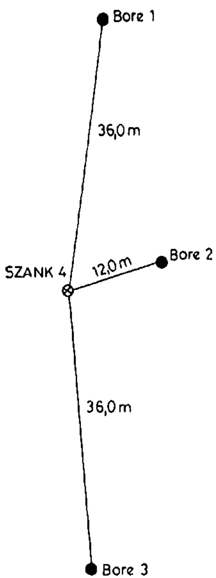


SAMPLES TAKEN FROM SURFACE			
symbol	carbon content %	humus content %	hydrocarbon content %
Ü 4/1	0,680	1,17	present
Ü 4/2	0,623	1,07	present
Ü 4/3	0,954	1,65	present
Ü 4/4	2,483	4,30	present

Figure 13.

Humus and hydrocarbon contents of soil samples taken from the surface, 11 years after gushing of hydrocarbon prospect drilling no. 4 at Ülles

SITE - PLAN



Layer sequence of bore 1		SAMPLE				
		depth	symbol	carbon content %	humus content %	hydrocarb. content %
yellow fine 0,30	muddy sand	-0,05	SZ-1/1	0,521	0,90	present
yellowish muddy 0,4	brown fine sand	-0,35	SZ-1/2	0,285	0,49	Ø
brow sand 0,70	fine	-0,50	SZ-1/3	0,534	0,92	present
yellow sand	fine (0,85)	-0,80	SZ-1/4	0,051	0,09	Ø

Layer sequence of bore 2		SAMPLE				
		depth	symbol	carbon content %	humus content %	hydrocarb. content %
yellow sand- 0,30	fine-sandy dust	-0,10	SZ-2/1	0,437	0,76	present
grey sand 0,45	fine	-0,30	SZ-2/2	0,068	0,12	Ø
yellow sand	fine (0,85)	-0,55	SZ-2/3	0,058	0,10	Ø

Layer sequence of bore 3		SAMPLE				
		depth	symbol	carbon content %	humus content %	hydrocarb. content %
some humus	cm	-0,05	SZ-3/1	0,458	0,79	Ø
sand interspersed with and filling	mud lumps humic	-0,20	SZ-3/2	1.745	3,02	present
0,40		-0,35	SZ-3/3	0,589	1,08	present
yellow sand	fine (-0,60)	-0,55	SZ-3/4	0,070	0,13	Ø

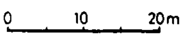


Figure 14.

Carbon, humus and hydrocarbon contents of deepened shallow borings and the individual layers in the vicinity of the hydrocarbon prospect drilling no. 4 at Szank

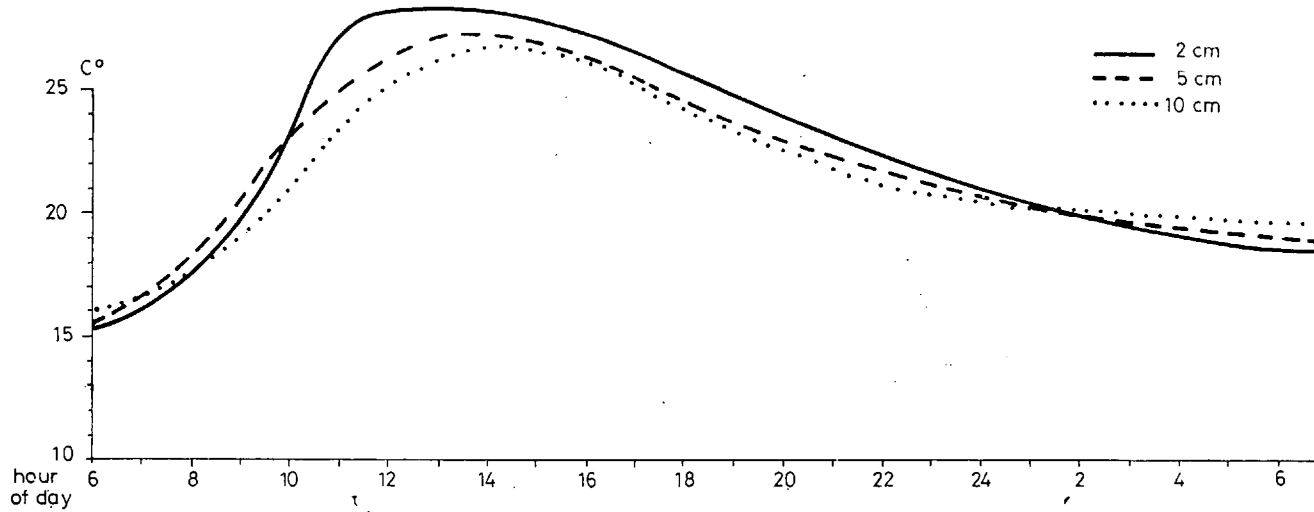


Figure 15

COURSE OF DAILY SUMMER TEMPERATURE OF SODIC MUD-SOIL NOT CONTAMINATED WITH HYDROCARBON, IN REGION OF ALGYŐ

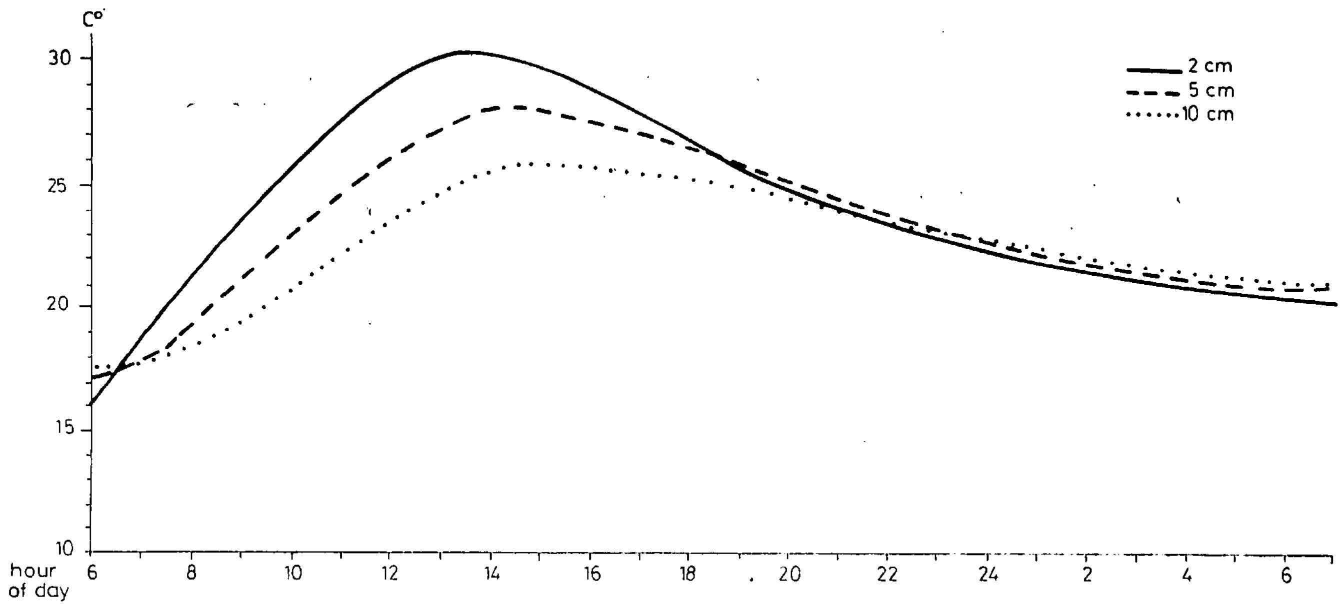


Figure 16.

COURSE OF DAILY SUMMER TEMPERATURE OF SODIC MUD-SOIL CONTAMINATED WITH HYDROCARBON, IN REGION OF ALGYŐ

SOIL-TEMPERATURE STRATIFICATION OF MEADOW CLAY NOT CONTAMINATED WITH OIL, IN REGION OF ALGYŐ

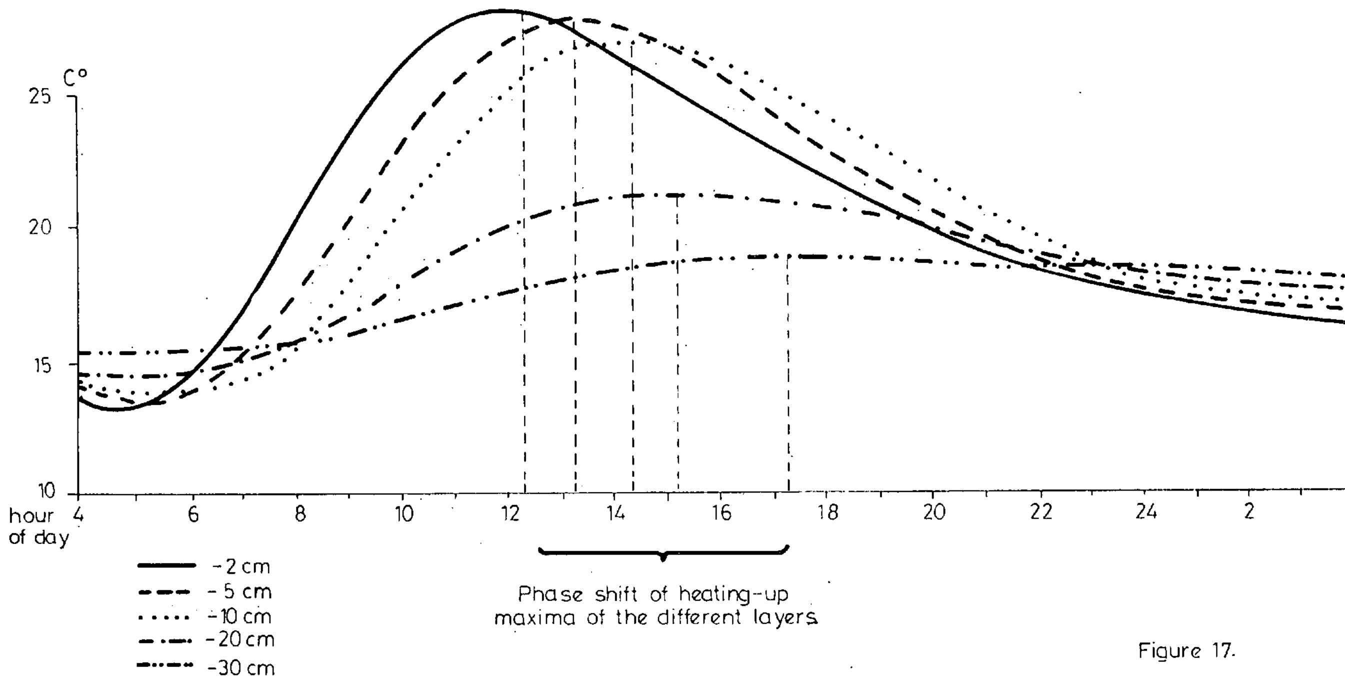


Figure 17.

SOIL-TEMPERATURE STRATIFICATION OF MEADOW CLAY CONTAMINATED WITH OIL, IN REGION OF ALGYÖ

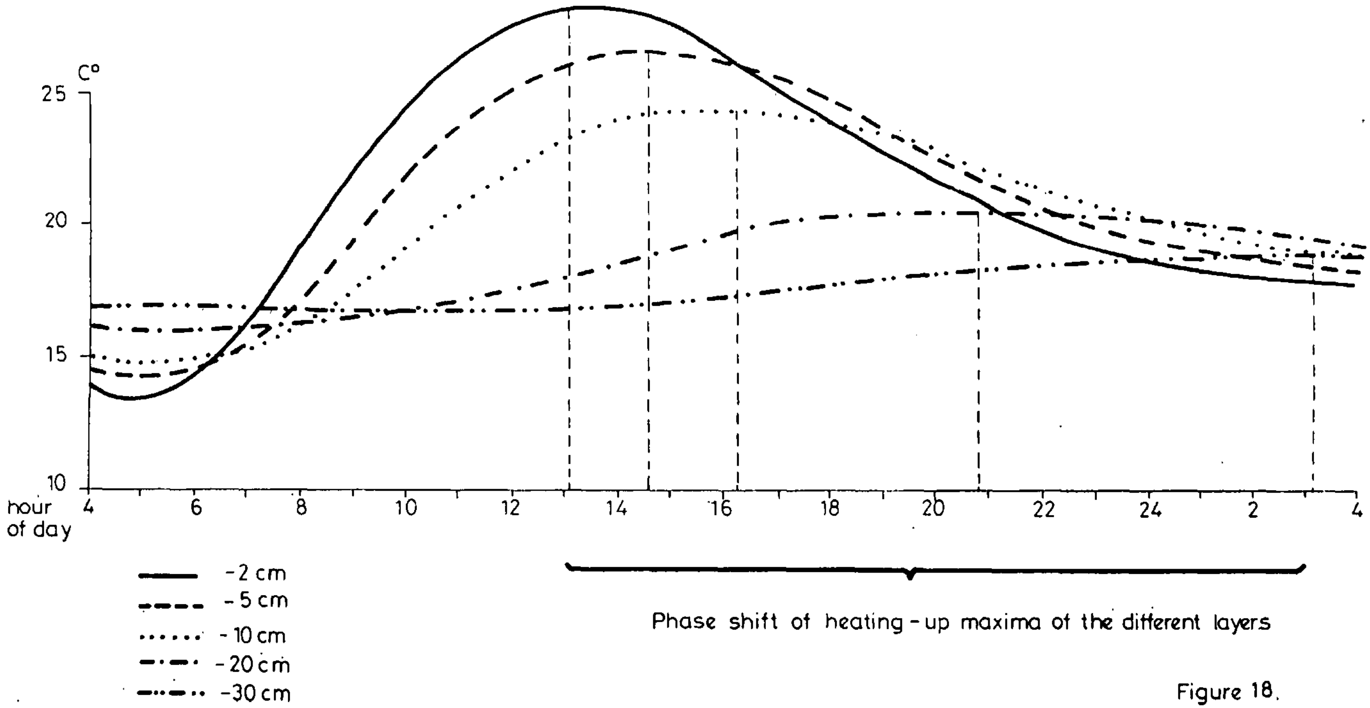
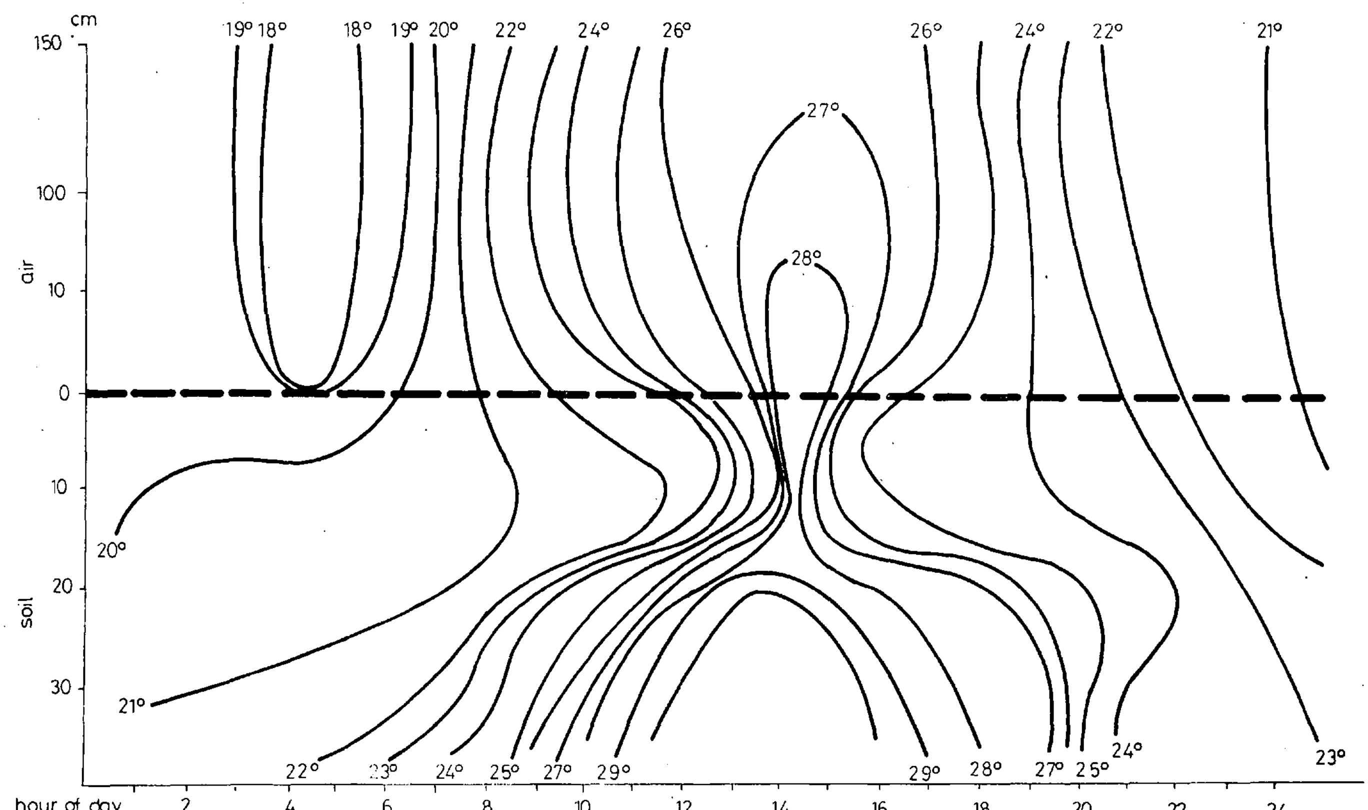


Figure 18.

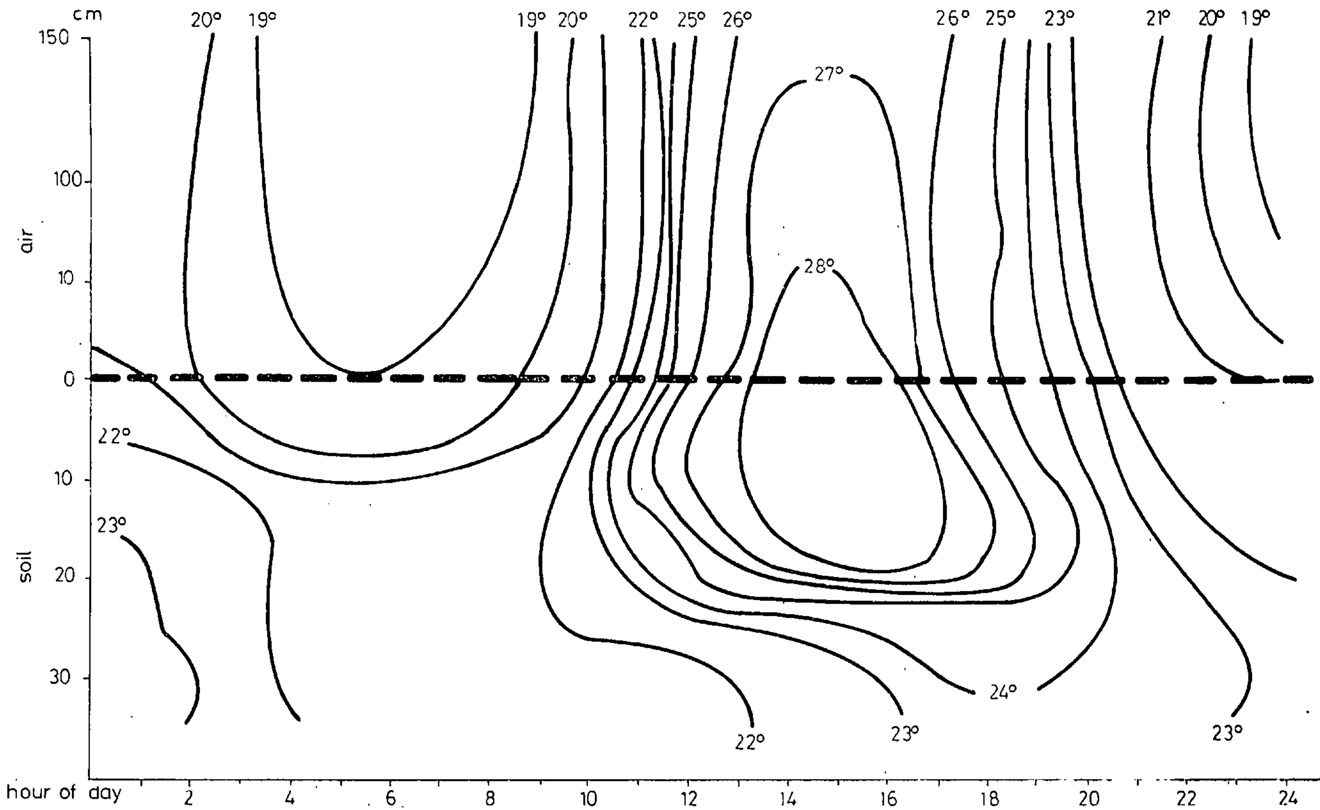
SUMMER TEMPERATURE ISOPLETS OF SODIC MUDDY LOESS SOIL NOT CONTAMINATED WITH HYDROCARBON, IN REGION OF KARDOSKÚT

Figure 19.



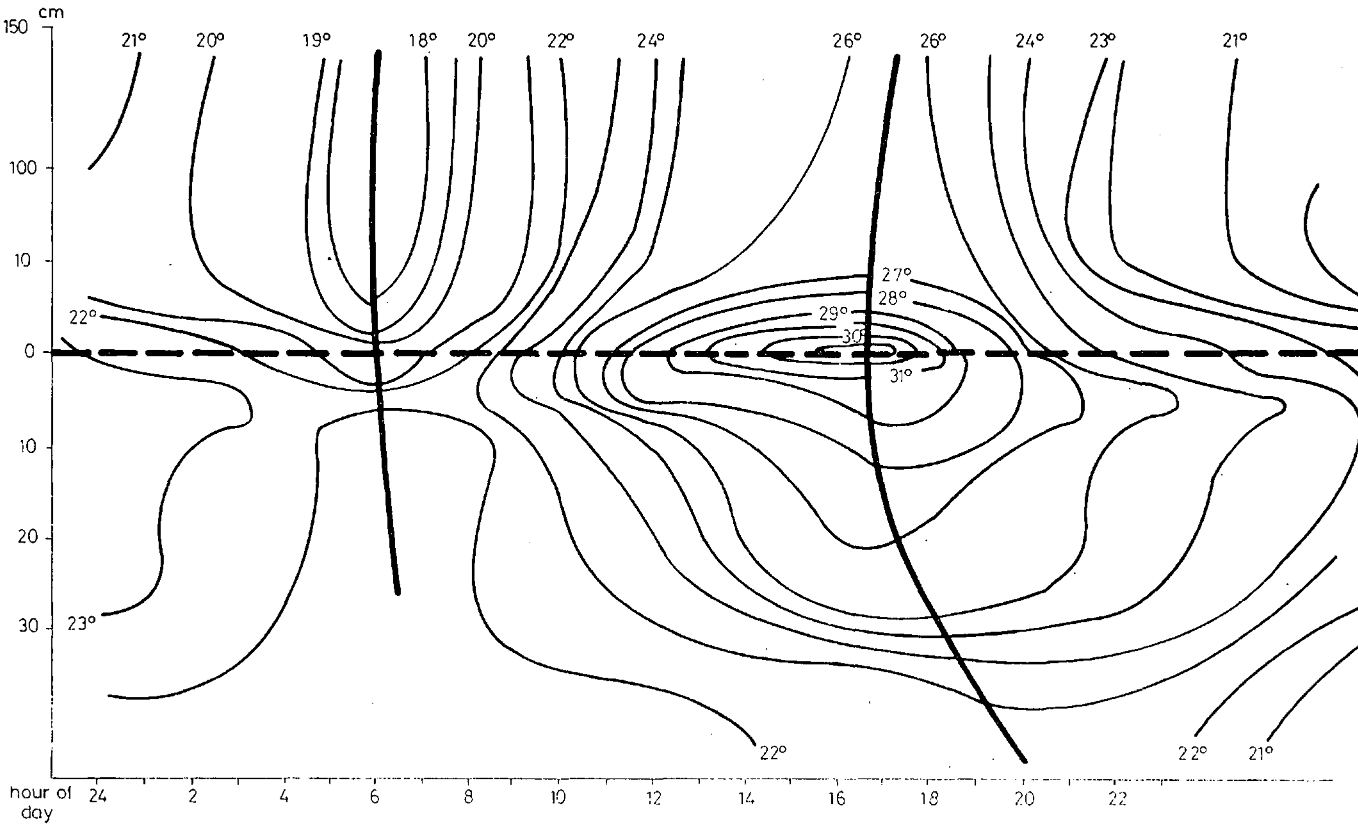
SUMMER TEMPERATURE ISOPLETS OF SODIC MUDDY LOESS SOIL CONTAMINATED WITH HYDROCARBON, IN REGION OF KARDOSKÚT

Figure 20.



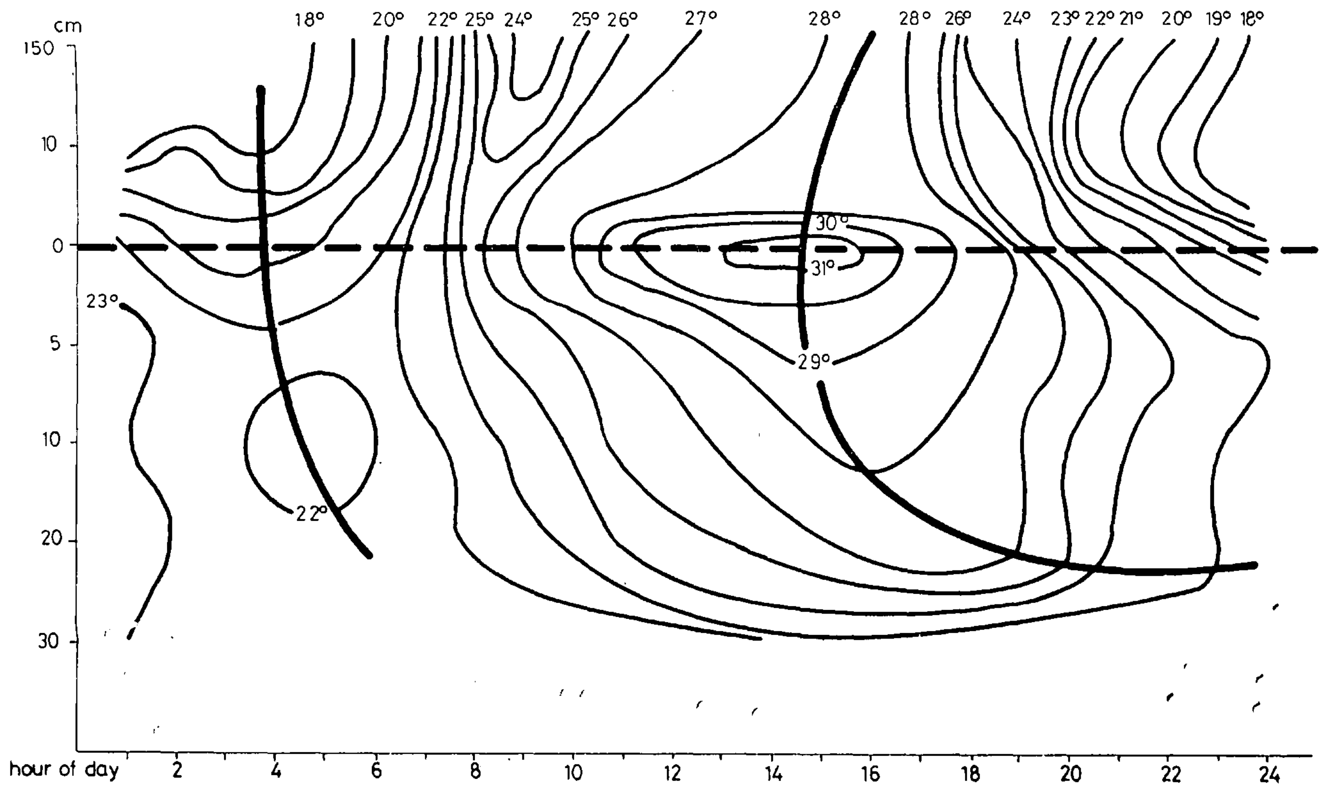
TEMPERATURE ISOPLETS OF MUDDY SAND NOT CONTAMINATED WITH HYDROCARBON, ON A BRIGHT SUMMER DAY AT SZANK

Figure 21.



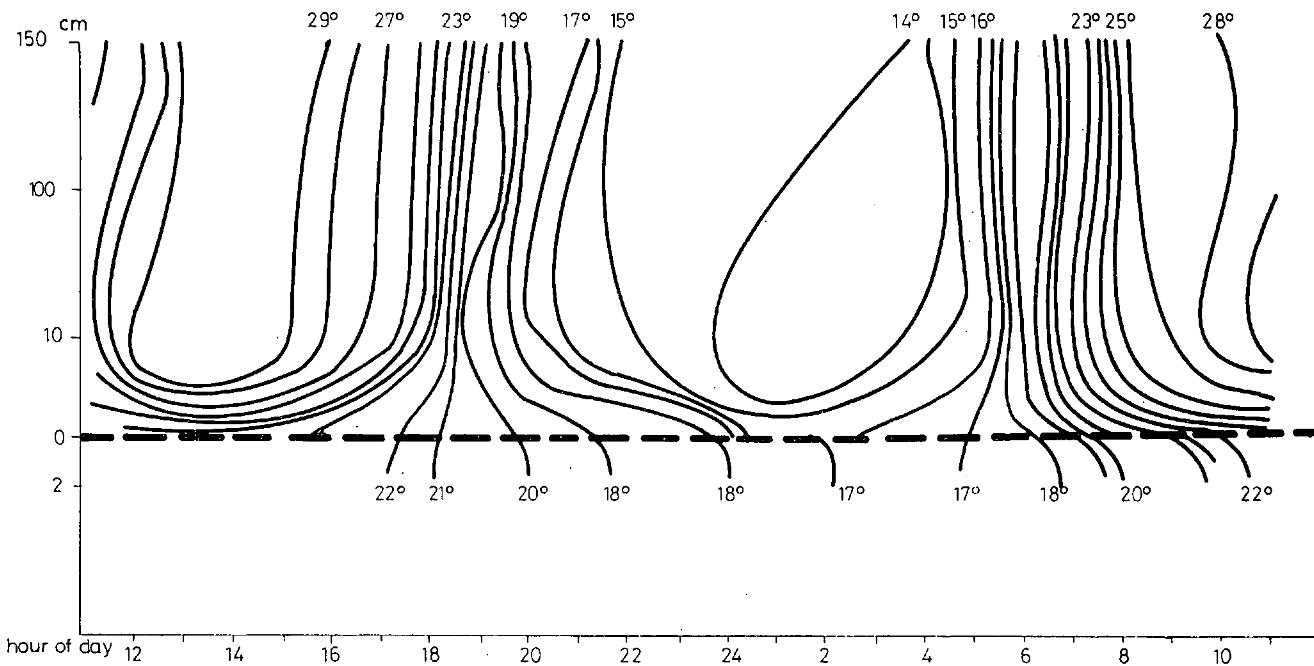
TEMPERATURE ISOPLETS OF MUDDY SAND CONTAMINATED WITH HYDROCARBON, ON A BRIGHT SUMMER DAY AT SZANK

Figure 22.



SUMMER TEMPERATURE ISOPLETS OF SANDY SOIL NOT CONTAMINATED WITH HYDROCARBON, IN THE REGION OF ÜLLÉS

Figure 23.



SUMMER TEMPERATURE ISOPLETS OF SANDY SOIL CONTAMINATED WITH HYDROCARBON, IN THE REGION OF ÜLLÉS

Figure 24.

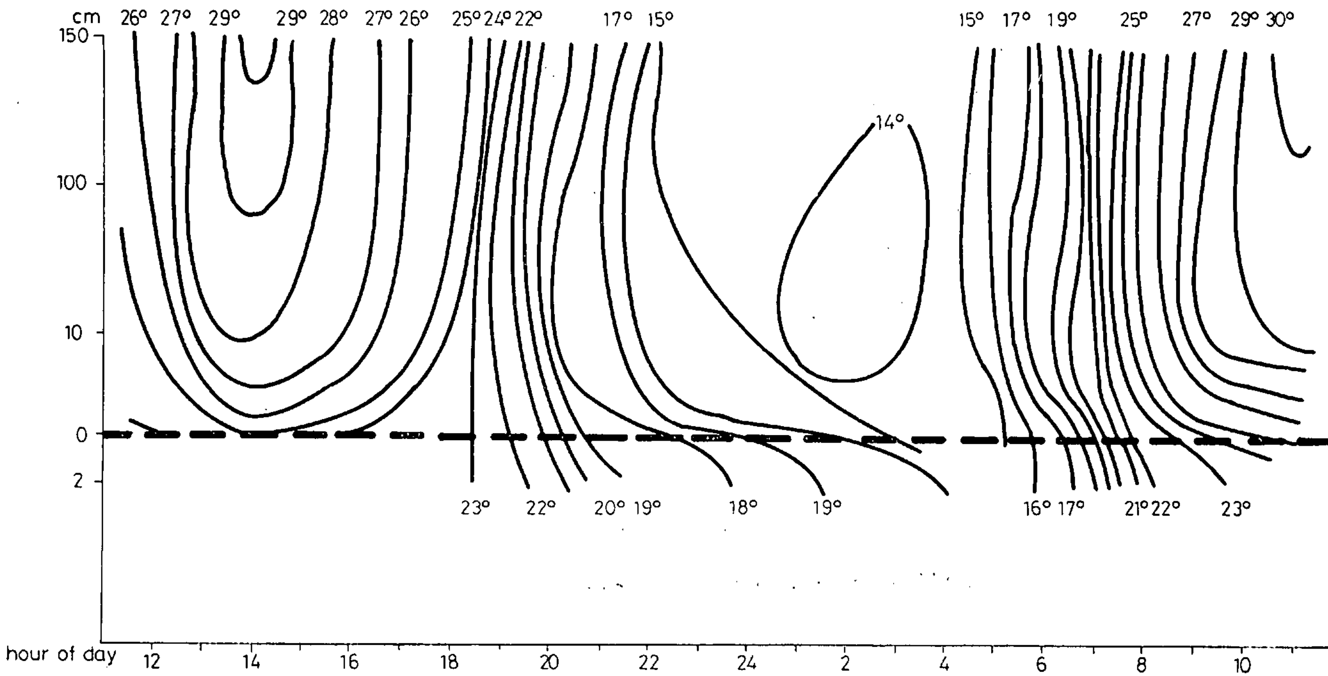


Fig. 25. Sandy soil transformed to desert in a maize field near Üllés on the action of mild oil-contamination. Only xerophyte semi-desert weeds remain on the bare patch.

the contaminated soil, with its poor thermal conductance capacity, and which therefore heats up strongly on the surface, ensures a more intensive radiation heat transfer to the air layer adjacent to the soil.

The mud mass which poured onto the surface on the occasion of the gushing in 1965 in the environment of bore no. 4 at Szank built up an entire, definitely perceptible, flattish hillock. Although the material of this has since been carted away and covered, nevertheless the contamination of the soil by hydrocarbon can clearly be seen on the sand. The daily temperature isopletes recorded here and on a nearby uncontaminated sandy area are shown in Figs. 21 and 22. These confirm that as a result of the oily contamination the sandy soil too changes its thermal household characteristics in the manner already discussed in connection with the more heavy soils.

As regards the Üllés sand, soil-temperature data exist only for a depth of 2 cm, but a whole series of air-temperature layer diagrams are available on the thermal household characteristics of the hydrocarbon-contaminated and uncontaminated sandy soils (see Figs. 23 and 24). These data support the earlier conclusions.

Accordingly, it is not at all surprising that *the plants are generally scorched in the oil-contaminated soils.* There are very few agricultural plants which are well able

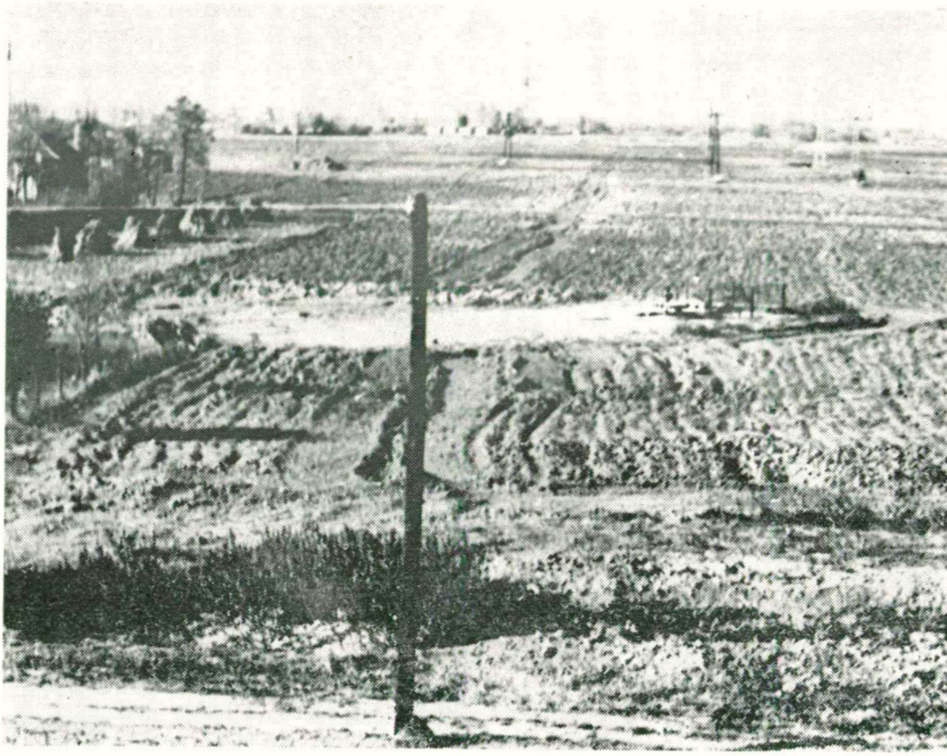


Fig. 26. A small naphthogenetic desert formed in the environmentof a drilling in 1972 at the edge of the village of Tápé, as a result of oil dripping from the mechanical installations. This has made the area so barren that it has not been cultivated since then.

to endure the considerable temperature differences at the various levels of the rhizosphere, which are typical in the heating-up period of the day, that is the morning, in hydrocarbon-contaminated soils. The nature of the soil here, and to some extent the air layers above it too, is reminiscent of desert conditions. The difference is simply that these deserts produced locally by the action of the oil are not climatogenetic deserts, but lithogenetic ones, and their characteristic differences in microclimate too are reflections of the soil effect.

In Figs. 25—27, therefore, some small "lithogenetic desert spots" are presented, the unproductiveness of which can not yet be eliminated by the chemization and irrigation methods known at present. Since such bare spots are undoubtedly caused by the oil contamination, however, they might justifiably be termed "naphthogenetic deserts".

Fortunately, naphthogenetic deserts today cover a very small overall area of the Great Hungarian Plain. The results of our approximate calculations indicate that an area of only about 200 hectares is involved to the south of the valley of the Körös rivers, and on the southern part of the area east of the bed of the Tisza. Even

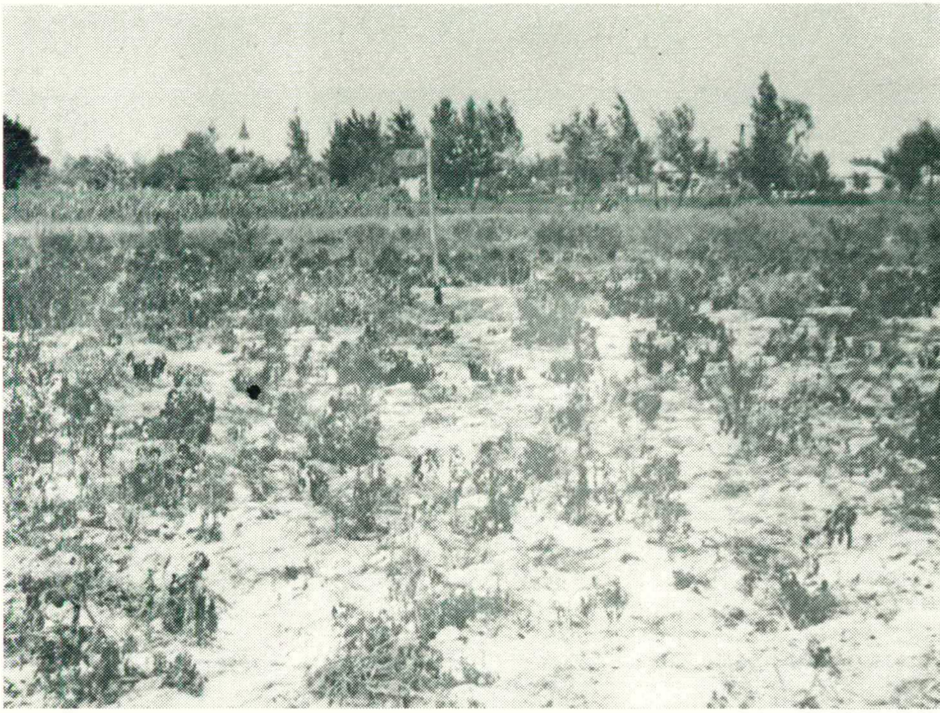


Fig. 27. Experiments in tomato production are now being made on the sandy soil transformed to one with a semidesert microclimate because of hydrocarbon contamination in the environment of bore no. 4 at Szank, with the results to be seen.

this, however, is worthy of attention. In the future, everything must be done to prevent the further spread of these "moon spots" in proportion to the increase of vehicular traffic and hydrocarbon production.

ROLE OF SOIL TEMPERATURE IN CONTROL OF DENUDATIVE PROCESSES OF DIFFERENT EXPOSURES IN KARSTIC REGIONS

ILONA BÁRÁNY

The differences in intensity of the denudative processes in the micro-areas of karstic surfaces are influenced not only by the thickness of the soil layer and by the composition of the vegetation covering the surface, but also by the control of exposure in interaction with these. In this respect the author has already dealt with the temperature and humidity conditions of the 10 cm air layer immediately above the surface on the example of sink-holes in the Bükk Mountains (BÁRÁNY I. 1974). In the present study the temperature conditions of the uppermost 30 cm soil layer are examined on 4 exposures (N, E, S, W) with regard to karst denudation effected via the soil.

In investigations of the CO_2 household of the soils of karstic micro-areas, JAKUCS L. (1970, 1971, 1973a, b) found that the CO_2 concentration determining the dissolution processes in the soil depends on the exposure. Via the aggressivity of the permeating precipitation water, the different CO_2 levels lead to differences in the intensity of the dissolution processes of weathering-away.

This presumably plays a large role in the development of the morphological shape of the large number of asymmetrical sink-holes in the Bükk Mountains, and in other karstic mountainous regions, too. The CO_2 level is closely connected with the temperature and moisture conditions of the soil.

According to the measurements of JAKUCS L., on a bright day in 1968 (17 August) the maximum of the CO_2 content of the soil was highest on the eastern exposure: 3.5% (Fig. 1); this is closely related with the fact that, on an average for 6 bright days, the morning temperature of the 5 cm soil layer here is higher than on the other exposures. The temperature maximum is around 21—22 °C, and it appears that this is the optimum soil temperature for CO_2 production. Similarly to the eastern exposure, the CO_2 level maximum on the southern exposure occurs at midday; however, the soil temperature maximum is somewhat later, and has a higher value.

It can be concluded from this that increase or decrease of the temperature from 21—22 °C has an impairing effect on CO_2 production.

Temperatures of the western exposure are close to the optimum, and favour bioactive CO_2 production, but temperatures below 20 °C on the northern exposure keep the CO_2 level low compared to the other exposures.

The above conclusive facts justify a study of the soil temperature in the various exposures. The course of the soil temperature in the eastern and western exposures was investigated by BOROS J. (1971), who found that the daily course of the tempera-

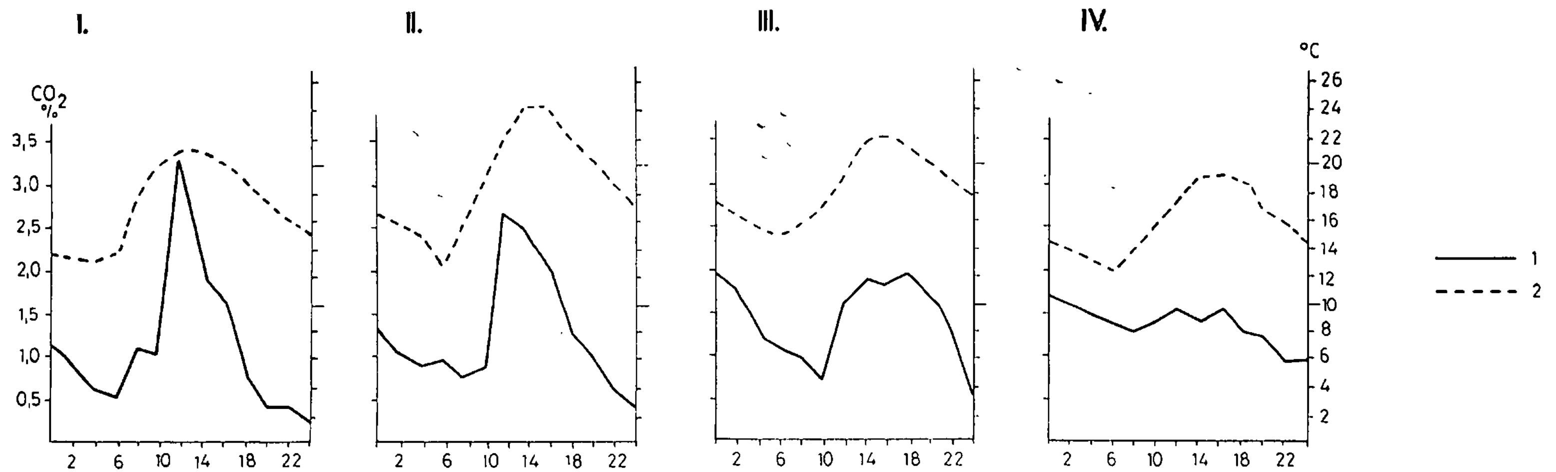


Fig. 1. Soil temperature and soil CO_2 concentration at a depth of 5 cm (CO_2 experimental data after JAKUCS L.)
I=eastern exposure; II=southern exposure; III=western exposure; IV=northern exposure.
1=CO_2 concentration (17 Aug. 1968);
2=average soil for 6 bright August days.

ture in the two exposures is regulated by the possible sunlight duration, the maxima conforming to the slope culmination.

Based on the microclimatic measurements made in the summers of 1969 and 1971 under the leadership of WAGNER R., the author studied the soil temperatures of the 4 different exposures as averages for bright days in an open sink-hole at Kurtabérc, and has attempted to distinguish the slope types from the soil temperature characteristics observed on these exposures.

The knowledge of the macroclimatic conditions for the given period was necessary for a correct evaluation of the microclimatic data recorded in August. In both 1969 and 1971, 6 bright days appeared suitable for investigations: in 1969, August 2, 3, 4, 5, 6, and 7; and in 1971, July 31, August 2, 7, 14, 15, and 18 (see Fig. 2.)

During the same period, the first 20 days of the month, there were 10 rainy days in 1969, and 5 in 1971. The 6 days selected in 1969 were the continuation of a

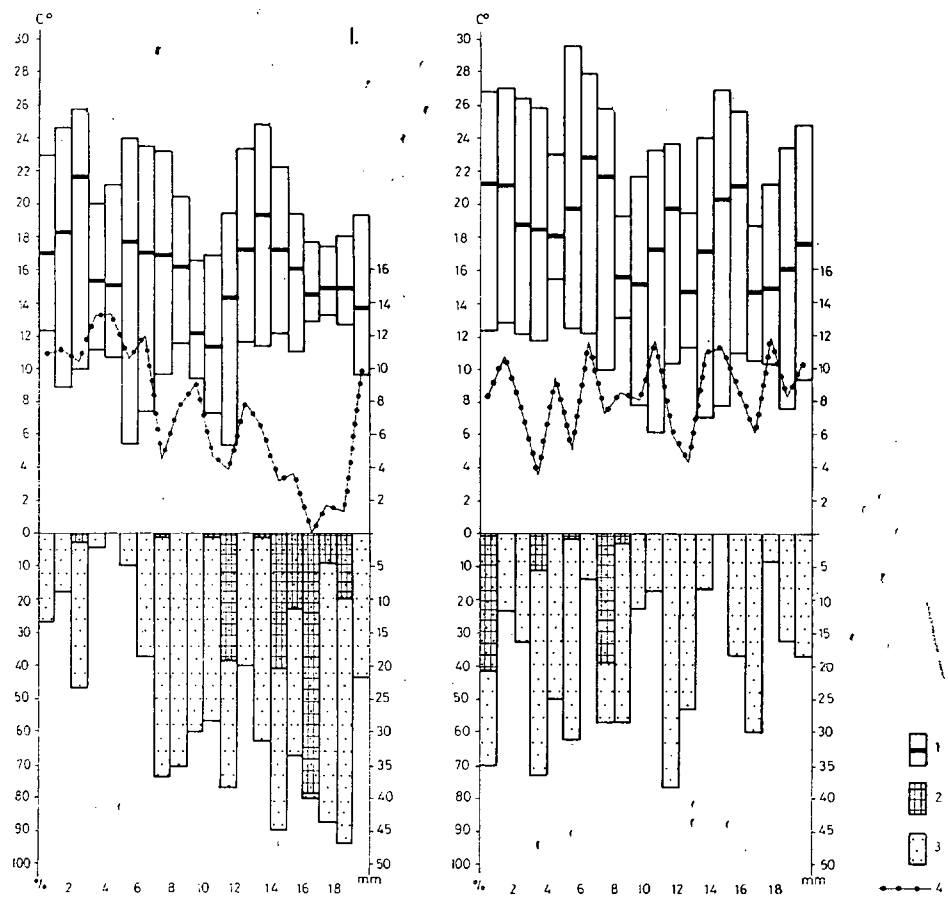


Fig. 2. Development of macroclimate at Kurtabérc at the time of the microclimatic measurements (1—20 Aug. 1969 and 1971)
I=1969; II=1971; 1=maximum, minimum and mean temperature; 2=precipitation; 3=cloud; 4=duration of sunlight.

nationwide bright, dry period at the end of July. The first wave of an air mass of polar origin, which arrived in the Carpathian Basin on August 4—5, resulted in a drop of temperature throughout the entire country. This also showed up in the values of the temperature maxima and average temperatures at Kurtabérc, and demonstrably moderated the heating-up of the soil, too. A similar temperature decrease due to cool advection occurred in 1971 only on August 18. Comparison of the August temperatures for the two years reveals that the daily maxima and minima on the selected bright days were lower in 1969 than in 1971. Since this also resulted in significant differences in the sizes of the temperature amplitudes, comparison of the various exposures will be free of distortion only if the given years are taken individually. (Microclimatic measurements were made on the northern and southern exposures in 1968, and on the western and eastern exposures in 1971.)

At depths of 2, 5, 10, 20 and 30 cm, in every exposure there is a regular phase delay with depth in the daily course of the soil temperature, and the temperature progressively decreases.

The soil temperature courses at the various depths on the 4 exposures were plotted as averages for the bright days with the aid of trigonometric polynomials (see Figs. 3—6).

At depths of 2 and 5 cm from the surface there is a larger difference in the phase shifts of the temperature courses on the eastern and western exposures, and in the size of the amplitudes on the northern and southern exposures. The heating-up begins earlier on the eastern exposure than on the western exposure, and the intensity of heating-up at the base of the sink-hole is also greater on the eastern exposure. At depths of 10 and 20 cm, however, the temperature is protractedly lower on the eastern exposure in the afternoon, and this state is also characteristic for the deeper levels. The shift in time of the occurrence of the maxima and minima is striking; this will be returned to in the discussion of the typical parameters.

At depths of 2 and 5 cm the temperature courses of the southern and northern exposures are nearly parallel, the temperature on the southern exposure naturally being the higher. At 10, 20 and 30 cm the amplitudes decrease in accordance with expectations.

Factual information on the differences in exposure is provided by the parameters of the trigonometric function of JORDÁN K. (1949):

$$f(x) = K + a_1 \sin(U_1 + 15x) + a_2 \sin(U_2 + 30x)$$

where K = mean temperature (°C),

a_1 = amplitude of the 12 hour wave (°C),

a_2 = amplitude of the 6 hour wave (°C),

U_1 = phase angle of the 12 hour wave (at zero degree position), and

U_2 = phase angle of the 6 hour wave (at zero degree position).

(The calculations were performed on the computer of the Cybernetics Laboratory of József Attila University.)

The characteristic parameters (see Table 1) give the possibility to examine a problem frequently raised by climatologists: the phase shifts with depth; a more important question here, however, is the analysis of the phase shifts relating to the different exposures.

At depths of 2 and 5 cm the mean temperature and the amplitudes are highest on the southern exposure. At depths greater than 10 cm the mean temperature con-

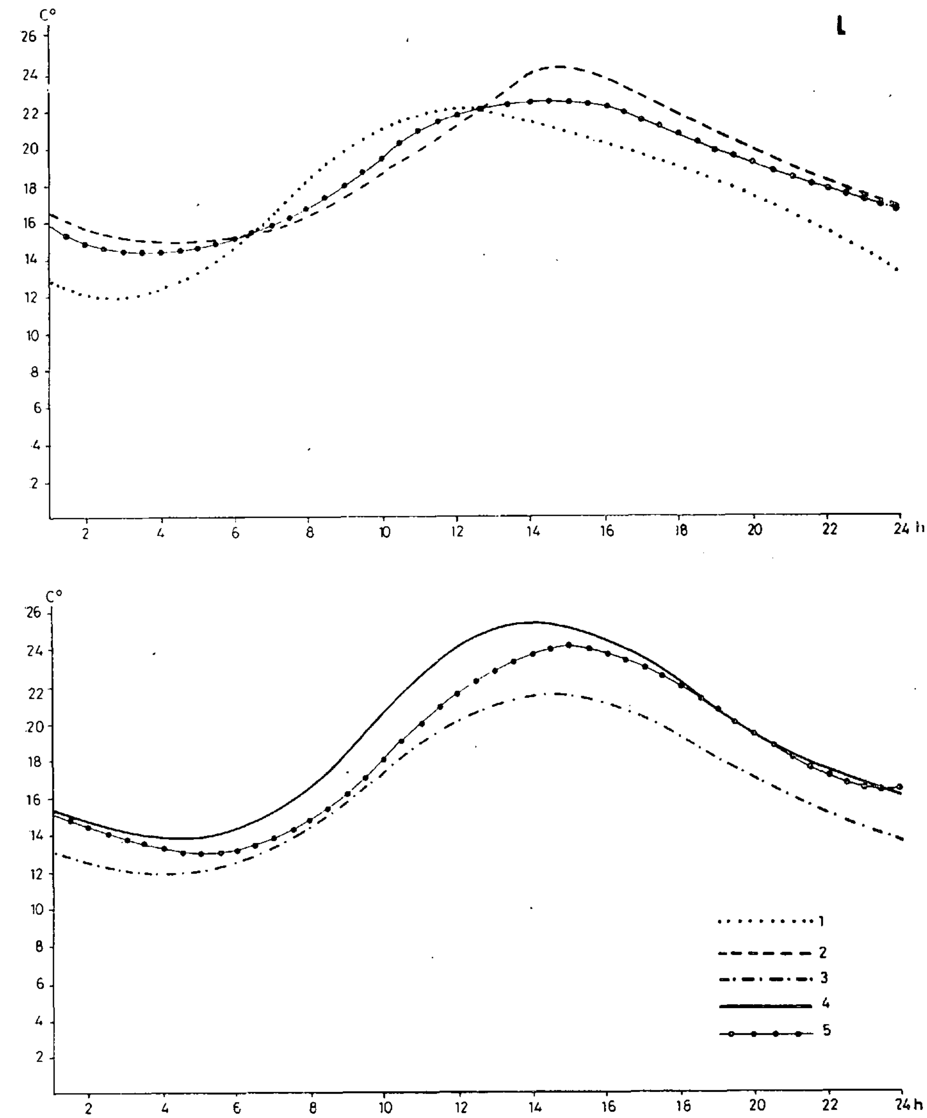


Fig. 3. Trigonometric polinomials at a depth of 2 cm I.
1=eastern exposure; 2=western exposure; 3=northern exposure; 4=southern exposure; 5=sink-hole base.

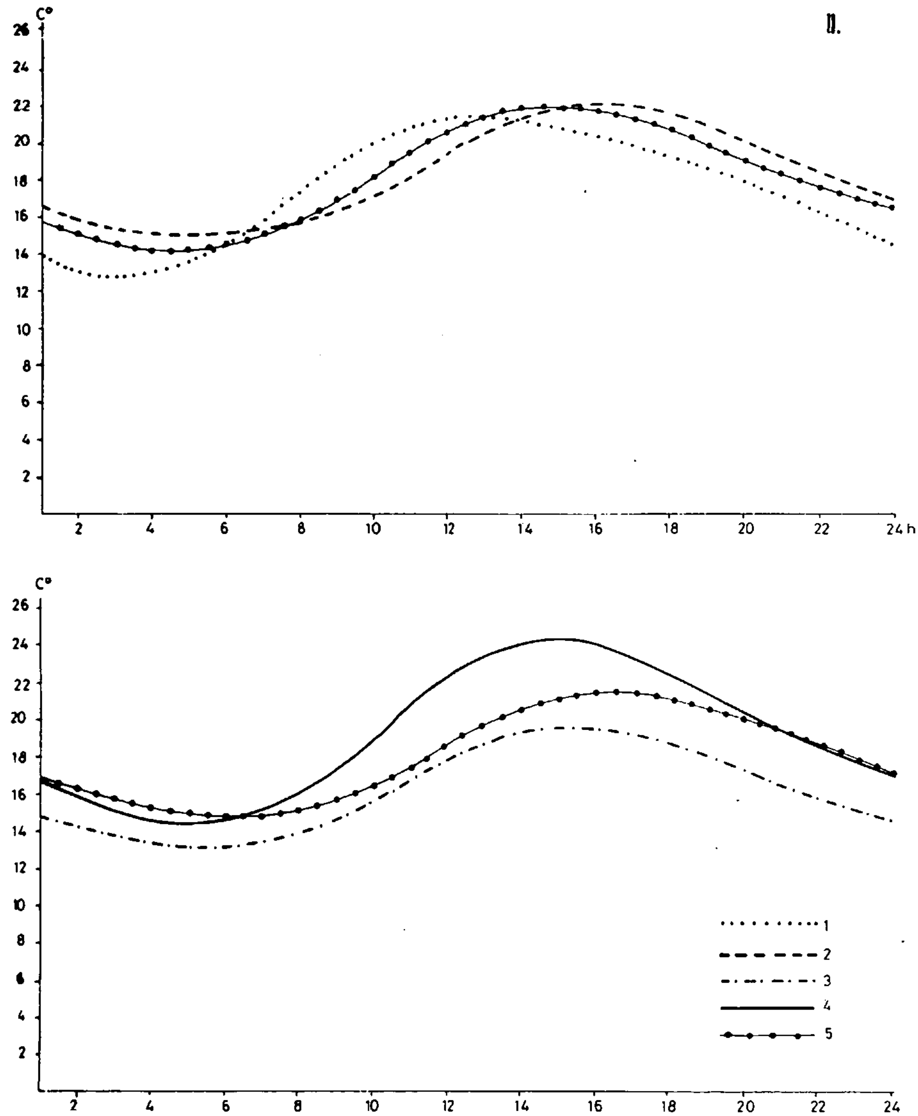


Fig. 4. Trigonometric polinomials at a depth of 5 cm II.
1=eastern exposure; 2=western exposure; 3=northern exposure; 4=southern exposure; 5=sink-hole base.

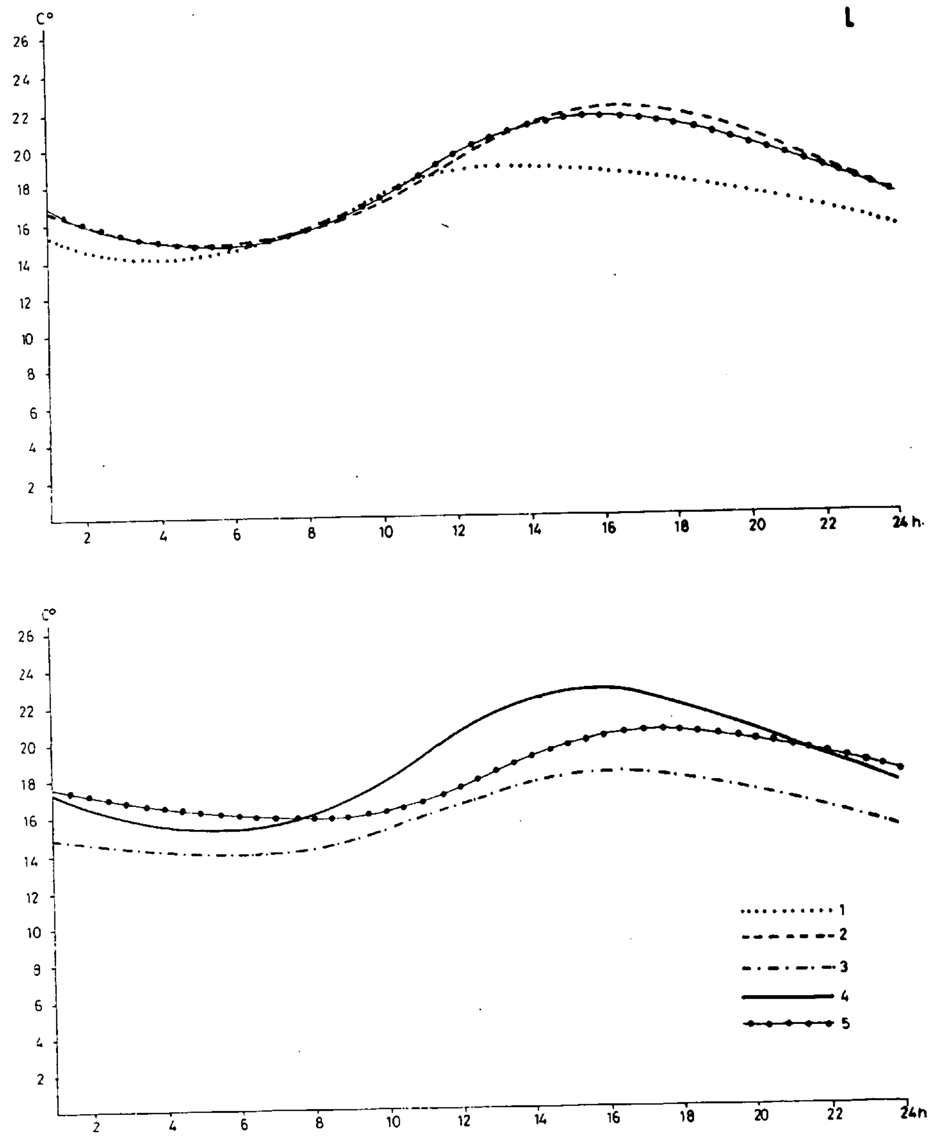


Fig. 5. Trigonometric polynomials at a depth of 10 cm I.
1 = eastern exposure; 2 = western exposure; 3 = northern exposure; 4 = southern exposure; 5 = sink-hole base.

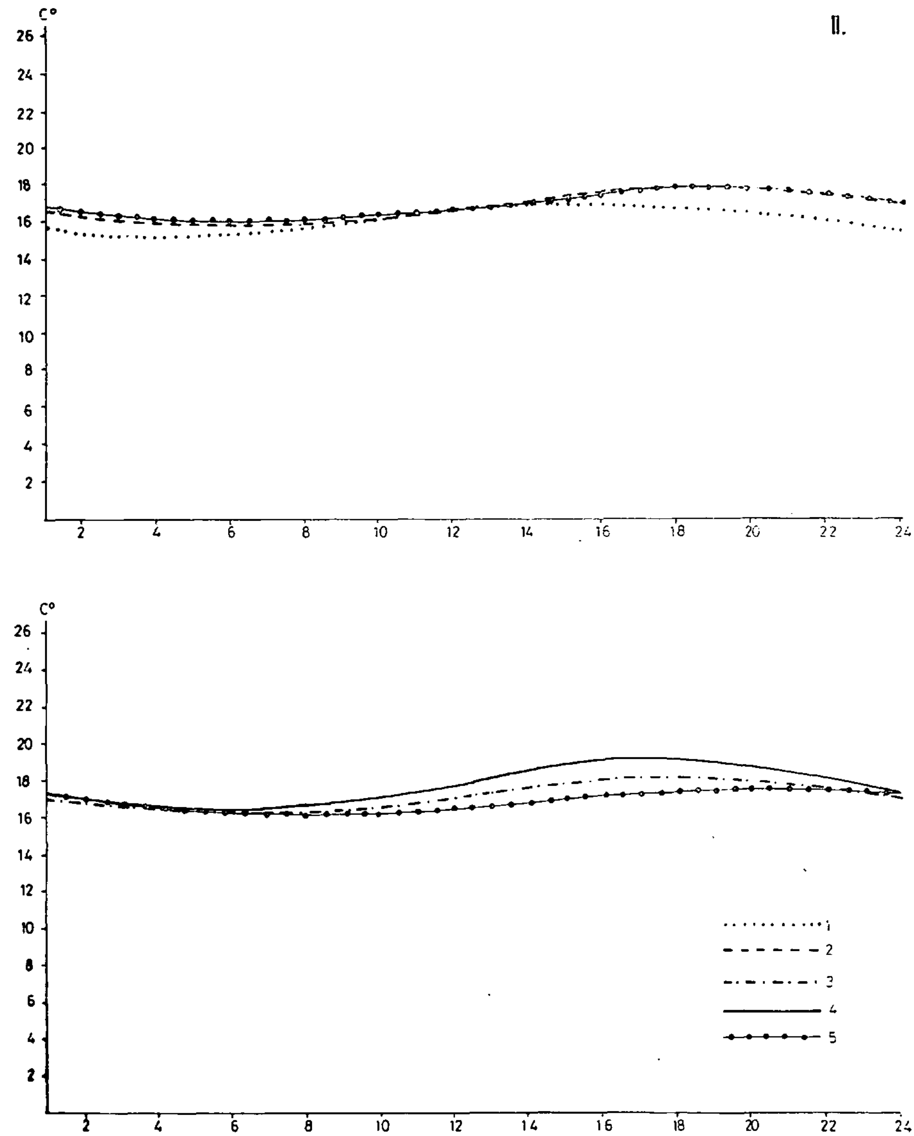


Fig. 6. Trigonometric polynomials at a depth of 20 cm II.
1 = eastern exposure; 2 = western exposure; 3 = northern exposure; 4 = southern exposure; 5 = sink-hole base.

tinues to be higher on the southern exposure, but the amplitude is higher on the western exposure. At all depths the lowest temperature is found on the northern exposure. At a depth of 2 cm the other three exposures exhibit a significant phase delay compared to the eastern exposure. On the western exposure this delay is 2 hours 6 minutes (1 hour$=15°$); at depths of 5 and 10 cm the difference is 2 hours 24 minutes and 1 hour 42 minutes, respectively. At depths of 20 and 30 cm the northern exposure shows a greater delay compared to the eastern exposure.

The transfer of heat towards greater depths requires the longest time on the northern exposure, the shift being 7 hours 24 minutes between 2 and 30 cm. The corresponding values on the eastern, western and southern exposures are 6 hours 6 minutes, 5 hours 42 minutes, and 5 hours 30 minutes, respectively.

The positions of the extreme soil temperature values, and the times of occurrence of these (see Table 2) conform to the above characteristics. The maximum arises first on the eastern exposure, and then on the southern, northern and western exposures. At depths greater than 10 cm the maximum for the western exposure precedes that for the northern exposure. A change of a similar sense as regards the minimum positions occurs between 10 and 20 cm. It may be concluded from the foregoing that between 10 and 20 cm there is a level where the rates of thermal transfer and thermal conduction change on the various exposures. Some data are already available in this respect, but the proof requires further analysis.

To sum up, therefore, it may be stated that the plots of the trigonometric polynomials and the maximum and minimum positions (averaged for the bright days investigated) indicate the soil temperature to develop in the most interesting way on the eastern exposure. It is here that the heating-up begins the soonest and with the greatest intensity, and here that the maxima and minima follow each other most rapidly on proceeding towards greater depths. The southern exposure comes next, with a more intense heating-up and a delay of at least 1 hour. After the southern exposure comes the northern exposure, with smaller maxima but a more uniform temperature course; this is hotter than the eastern exposure, because of the more protracted, higher temperatures in the afternoon.

The northern exposure is the coldest; it is here that the maxima succeed each other with the greatest phase difference between depths of 2 and 30 cm. On the basis of the courses smoothed out with the aid of harmonic analysis too, the exposure features characterizing the soil temperature are in synchronism with the initially discussed exposure differences of biogenous carbon dioxide production and plant evaporation. In this way the earlier research results are interpreted in a new light.

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Table 1.

Characteristic data of the trigonometric polynomials

Exp. \ Depth.	2 cm					5 cm					10 cm					20 cm					30 cm				
	K	a_1	a_2	U_1	U_2	K	a_1	a_2	U_1	U_2	K	a_1	a_2	U_1	U_2	K	a_1	a_2	U_1	U_2	K	a_1	a_2	U_1	U_2
E	17,3	4,8	1,1	117	208	17,3	4,0	0,9	124	223	16,7	2,2	0,5	139	251	16,1	0,7	0,1	149	196	15,8	0,3	0,0	209	162
S	19,0	5,5	1,1	136	126	19,0	4,7	1,0	148	136	18,7	3,4	0,6	158	165	17,6	1,2	0,2	179	203	17,3	0,2	0,1	219	182
N	16,3	4,7	0,6	137	144	16,0	3,1	0,5	153	162	15,8	2,1	0,3	166	182	15,1	0,9	0,1	188	196	15,0	0,2	0,0	249	105
W	18,7	4,1	0,6	149	170	18,2	3,6	0,5	161	192	18,3	3,5	0,4	165	204	16,8	1,0	0,1	193	143	16,3	0,4	0,1	235	205

Table 2.

Maximum and minimum positions, and times of their occurrence

Exp.	Depth.	2 cm		5 cm		10 cm		20 cm		30 cm	
		Position	Time	Position	Time	Position	Time	Position	Time	Position	Time
E	max.	207	13^h48^m	214	14^h18^m	229	15^h18^m	239	15^h54^m	241	16^h06^m
	min.	27	1^h48^m	34	2^h18^m	49	3^h18^m	59	3^h54^m	61	4^h06^m
S	max.	224	14^h54^m	238	15^h48^m	249	16^h36^m	259	14^h12^m	309	20^h36^m
	min.	44	2^h54^m	58	3^h48^m	68	4^h30^m	79	5^h12^m	129	8^h36^m
N	max.	227	15^h06^m	243	16^h12^m	256	17^h00^m	278	18^h30^m	339	22^h36^m
	min.	47	4^h06^m	63	4^h12^m	76	5^h00^m	98	6^h30^m	159	10^h36^m
W	max.	239	15^h54^m	251	16^h42^m	255	17^h00^m	257	17^h06^m	325	21^h42^m
	min.	59	3^h54^m	71	4^h42^m	75	5^h00^m	77	5^h06^m	145	9^h42^m

SYSTEM OF OCCURRENCE OF GAS-CONTAINING WATERS OF ARTESIAN WELLS ACCORDING TO REGION AND DEPTH IN THE SOUTHERN PART OF THE HUNGARIAN BASIN

J. FEHÉR

In the Hungarian basin there are many artesian wells, and water-prospecting and test drillings of low or medium depth, which produce gases of various compositions together with the water. These cause technological problems during the production and utilization of the water, while there is a danger of explosion in the case of combustible gases. Attention was directed to the problems of gas-containing water wells by these practical difficulties, by a number of accidents, by the lack of a solution to certain scientific questions connected with the gases coming to the surface together with the water, and by the possibility of utilizing in hydrocarbon prospecting the consequences to be drawn from the results of the investigations.

The question of the origin of the gases is still unclarified. It is not decided whether these are marsh gases partially or completely of biogenous origin, or whether they are natural gases formed in the deeper layers of the Hungarian Plain, mainly in the inland-sea and lake formations of the Pannonian Age, and dissolved in the layer-water, after permeating upwards by migration. According to the literature, the marsh gas "may be distinguished from fossil hydrocarbon gases in part *on the bas of the conditions of occurrence*, and in part *by establishing the chemical composition*" (KERTAI, 1972, p. 67).

The different authors in general agree that geochemical examinations might give an answer as to the origin, for in young marsh gas, which is a gas mixture of mainly hydrocarbon, carbon dioxide and nitrogen, the only hydrocarbon present is methane (CH_4); in contrast, true natural gas, fossil hydrocarbon gas migrated from older geological formations, contains not only methane, but also higher molecular weight hydrocarbon gases: ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), etc. However, the gas analyses carried out sporadically earlier in the area under study do not give the detailed exact composition as regards the gas components (the combustible gases are uniformly listed as methane), while the low number of more recent and more detailed gas-analytical examinations do not permit the question to be decided on a geochemical basis.

This problem has been touched on by many authors in the course of research into the formation, migration and accumulation of hydrocarbons. The fundamental investigations of DANK (1970), KERTAI (1972), KÖRÖSSY (1971, 1973), TÓTH (1970), HUNT (1968), SHOKHOLOV—CHEREMISINOV (1971), SMITH—ERDMAN—MORRIS (1971) and others consider the question primarily on mineral-oil geological and geochemical bases. SCHMIDT (1939—40, 1940), STEGENA (1972), ERDÉLYI (1973), and most recently BÉLTEKY—KORIM (1974), treat the regional location of the gas-containing wells, and the possibilities of their migrational connec-

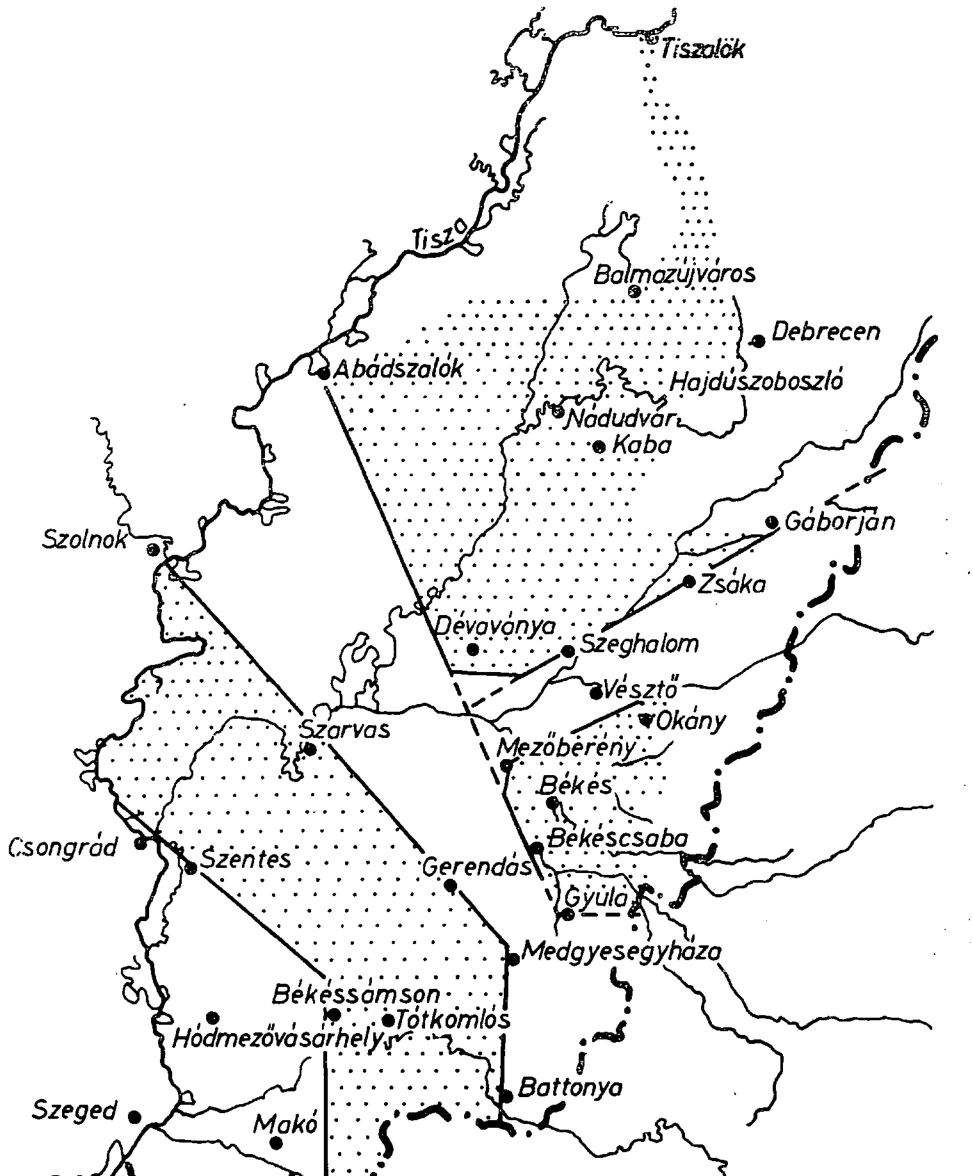

Fig. 1. Natural-gas regions east of the Tisza on the Hungarian Plain (after SCHMIDT, 1940).

tion with the natural-gas sites, mainly in the light of hydrological and hydrogeological aspects.

After a study of several thousand Hungarian artesian wells, as early as 1940 SCHMIDT constructed a map in which he classified practically all of that part of Hungary east of the Tisza as gas-bearing (Map 1). From the fact that the gas-bearing areas on his map form a band 80—100 km wide, lying by and large in the N—S direction, Schmidt came to the conclusion of the existence of a plain fracture-system, which, starting from the valley of the Hernád, cuts across the whole of this area beyond the Tisza in the N—S direction. In his view this rupture-system facilitates the gas migration from the deep-lying gas-storing structures, and upwards from the mother rock; this might have caused the accumulation of gas in the less deep layer-waters. Schmidt also pointed out that there are significant differences in the gas contents of the wells in the various regions and at the various depth levels.

The picture of the regional distribution of the gas-containing wells was added to and made somewhat more accurate by the map of ERDÉLYI (1973) (Map 2). This plots the area of extent of the gas-containing waters originating from the water supplies at depths of 100—400 m as a contiguous region including the major par of the country east of the Tisza, and within this also indicates smaller areas where the wells not so deep as 100 m are gas-bearing. Erdélyi further maps the scatteres gas-yielding wells too.

From a comparison of the maps of Schmidt and Erdélyi with the map illustrating the Hungarian hydrocarbon gas sites BÉLTEKY—KORIM (1974) came to the conclusion that "the not too deep drinking-water wells above the natural-gas fields in the counties east of the Tisza contain gas, while the water of wells drilled to date in low-depth drinking-water levels above the hydrocarbon sites west of the Danube and in the region between the Danube and the Tisza has not been shown to contain gas" (p. 84).

These findings are contradicted by the publication of STEGENA, who subjected the gas from drinking-water wells at depths of 200—300 m (2 in Felgyő and 2 in Csongrád) to gas-chromatographic analysis. He decided that the gas does not originate from the deep-lying hydrocarbon sites, but is formed in biogeneous processes near to the surface.

To promote decisions in connection with the undoubtedly large number of open questions, the present author wishes to contribute with a detailed investigation of the conditions of occurrence of gases coming to the surface with the water of the wells.

In the first phase of the work the area of the South Hungarian Plain was investigated; via the study of the documentation of every water-prospecting drilling made up to the end of 1974, the data of 18,052 water wells were processed. Of these, 2560 proved to contain gas, i.e. 14.17% of the total number of wells. The distribution of the wells on the South Hungarian Plain is very uneven. The average density fluctuates between 0.04 and 4.64 wells per km^2. In our view, therefore, the extent of gasification of the water-yielding layers in a given area may be assessed more realistically from the ratio of the gas-bearing and not gas-bearing wells, rather than from the absolute number of gas-bearing wells there. For example, in the region of Kiskőrös 9 of the 1081 wells contain gas and in the region of Méhkerék 4 of the 11 wells contain gas. 9, of course, is larger than 4, but nevertheless the region of Méhkerék must be considered to bear more gas, for the percentage of affected wells

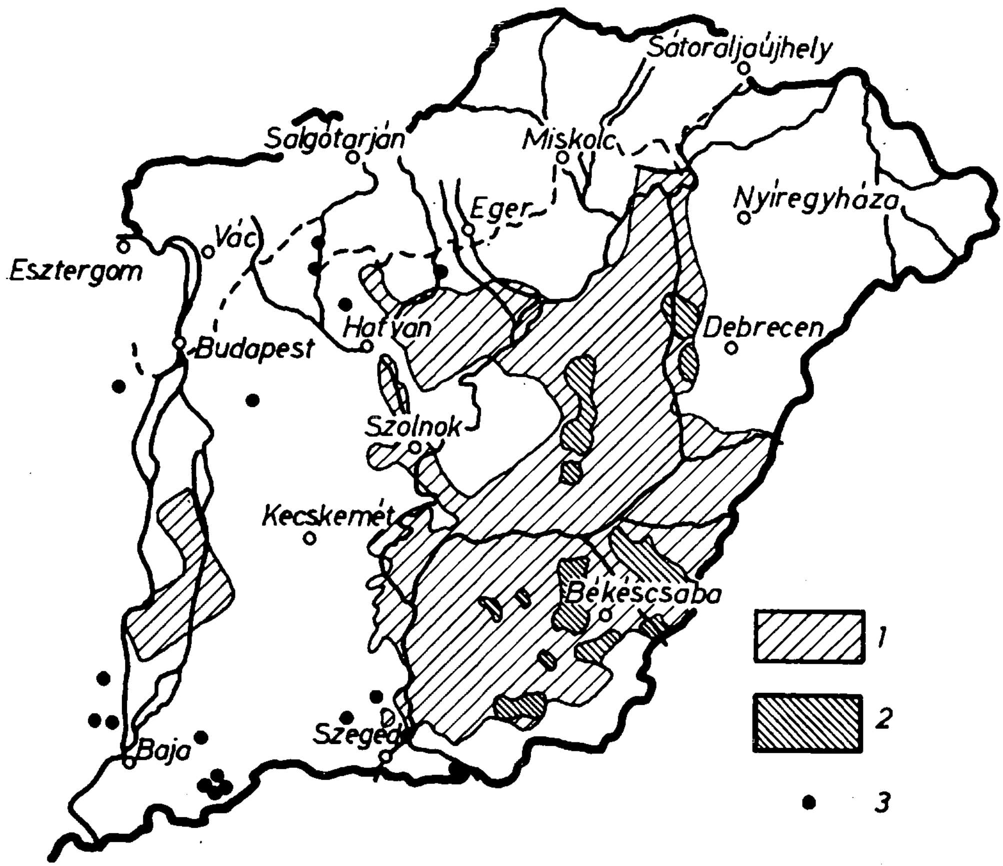

Fig. 2. Gas-containing layer-water wells on the Hungarian Plain (after ERDÉLYI, 1973)
1 = gas-bearing area, where the depth of the water-yielding layer is 100—400 m
2 = area where wells not deeper than 100 m are also gas-bearing
3 = gas-containing layer-water wells outside the gas-bearing area

is 36%, whereas at Kiskőrös it is less than 1%. It is not advisable to draw far-reaching conclusions from these rough percentage values, but it may be accepted that the higher value expresses a higher degree of gasification of the area.

For an analysis of the conditions of occurrence of the gas-containing waters, it is essential to map their geographical extents so as to show the regional differences in the degree of gasification, and the regional characteristics of the relative frequency of the gas-bearing wells in both horizontal and vertical directions. This was achieved by the following method: The administrative districts of the settlements served as the regional units. Every well in the inner and outlying areas of each community was taken into account, and the percentage ratio of the number of gas-bearing wells to the total number was determined. The total area of the community on the map was given a categorizing number in accordance with the percentage value, to express the degree of gasification. But there are some communities where the total number of controllable wells is only 1—2. The areas of these were considered uncategorizable; they are symbolized on the map by (−), to distinguish them from those districts where the proportion of gas-bearing wells can be evaluated, but is 0%.

Map 3, which shows the regional distribution and proportions of the gas-bearing wells on the South Hungarian Plain, well expresses the regional differences, but it does not permit a vertical evaluation of the gas-containing watery-ielding layers. On the basis of this map, the regions of low-depth, gas-bearing (in all probability marsh gas) wells can not be distinguished from the regions of wells several hundred metres deep and containing gas presumably as a result of the migration of real natural gas. For this reason the above method was applied to determine the proportions of the gas-bearing wells of different depths (0—30 m, 30—200 m, 0—200 m, 200—500 m and greater than 500 m) as percentages of the total number of wells at the given levels.

Even in the present stage of the research, the results of our investigations, Maps 3, 4 and 5, and the graphical diagrams showing the distribution by depth of the gas—bearing wells for the individual communities provide an information basis suitable for a more detailed recognition than hitherto of the regional and vertical systems of the gas—bearind wells on the South Hungarian Plain, and for the drawing of certain conclusions.

These maps clearly prove that the rock facies conditions play an important role in the geographical distribution of the gas—containing water—yielding layers of different depths on the South Hungarian Plain. It can thus be explained why there are only scattered gas — containing wells in the area between the Danube and the Tisza, which exhibits a sandy talus structure, why there is virtually no gas at all in the wells ob the Ősmaros grawelly—sandy talus in the district of Kunágota in the south-east, and why gas-containing waters are relatively very frequent in the region of the potamogenous plain east of the Tisza, which is richly endowed with limnic clays and impermeable flood-area mud layers.

Although Map 3 does not completely contradict the earlier-mentioned finding of Bélteky—Korim, it does not support their assumption of the direct connection of the gasification of the water-yielding wells and the natural-gas fields. Our map indicates that above and in the close environment of the most important natural-gas fields the proportion of gas-bearing wells varies between 0 and 25%. In contrast, the highest proportion of gas-bearing wells proves to be found in just those deep-lying parts of the basin to the east of the Tisza in which mineral-oil and natural-gas deposits are not known. For instance, around Földeák and Tiszazug the relative frequency of gas bearing wells is 78%, while in the area enclosed by Öcsöd, Eperjes and Hódmezővásárhely and in the districts of Tarhos and Murony in the region of the Békés depression it is 51—75%.

On the basis of the detailed map processing, the regional distribution of the gas-bearing layer-water wells east of the Tisza does not confirm the linearity along the N—S fracture line assumed by Schmidt, and nor is it in agreement everywhere with the earlier maps. The map of Erdélyi indicates gas-bearing wells not deeper than 100 m on a fairly extensive area to the west of Békéscsaba. Our investigations show that the frequency of gas-bearing wells here with depths of 0—30 m is 0%, and down to 500 m is at most 0—10%. On the other hand, higher values than this were found in the adjacent areas.

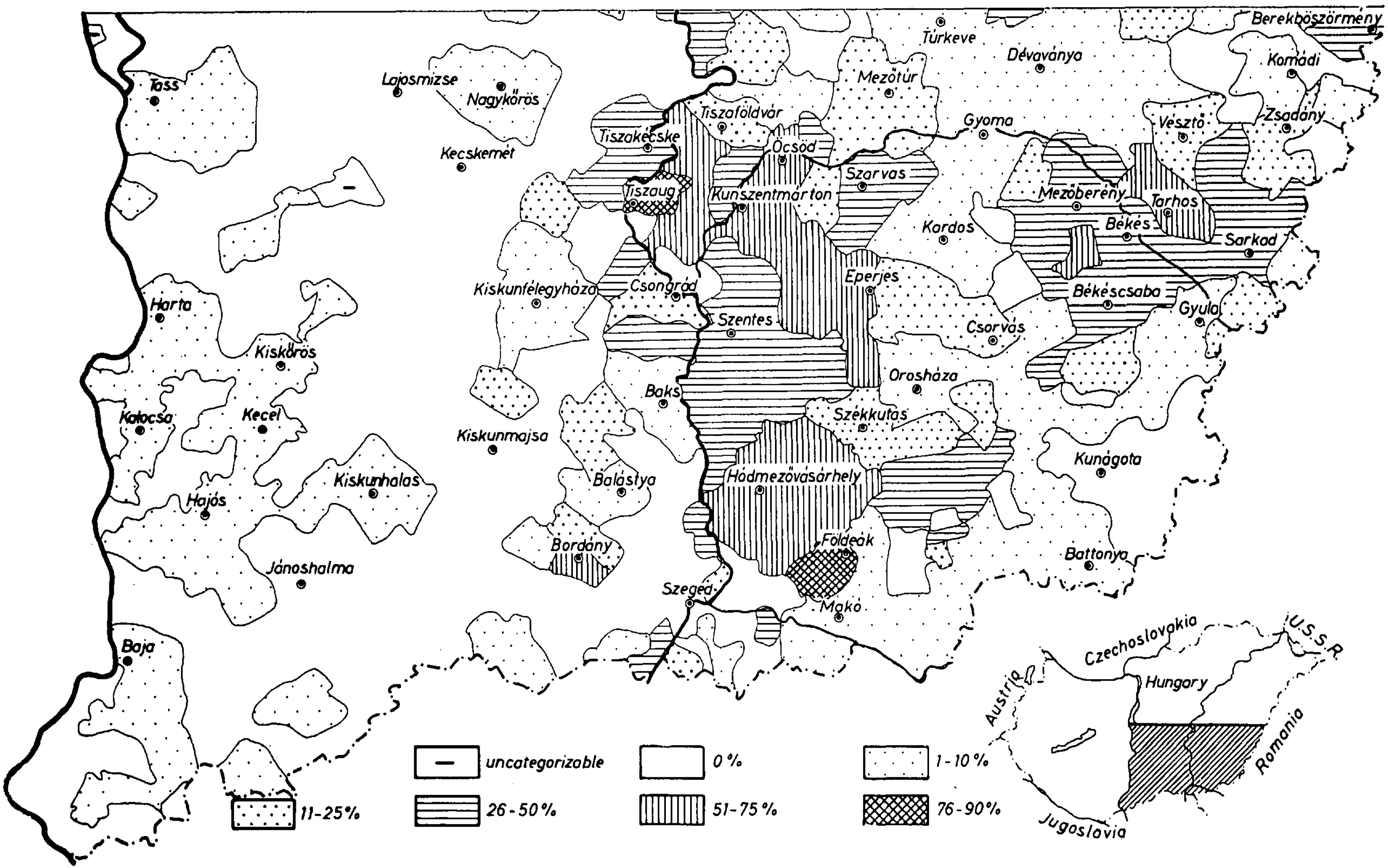

Fig. 3. Proportion of gas-containing layer-water wells on the South Hungarian Plain

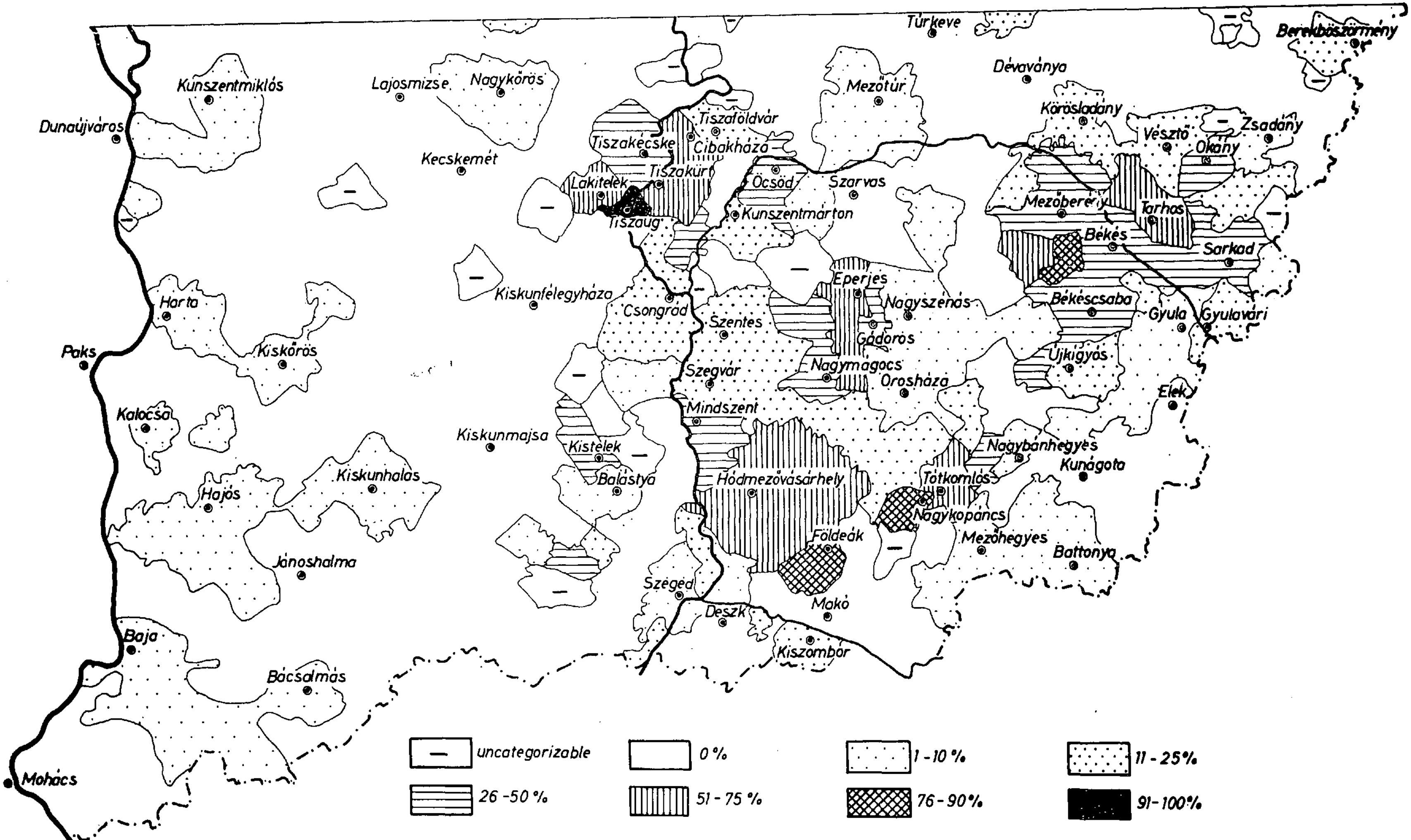

Fig. 4. Proportion of the gas-containing layer-water wells at a depth of 0—200 m

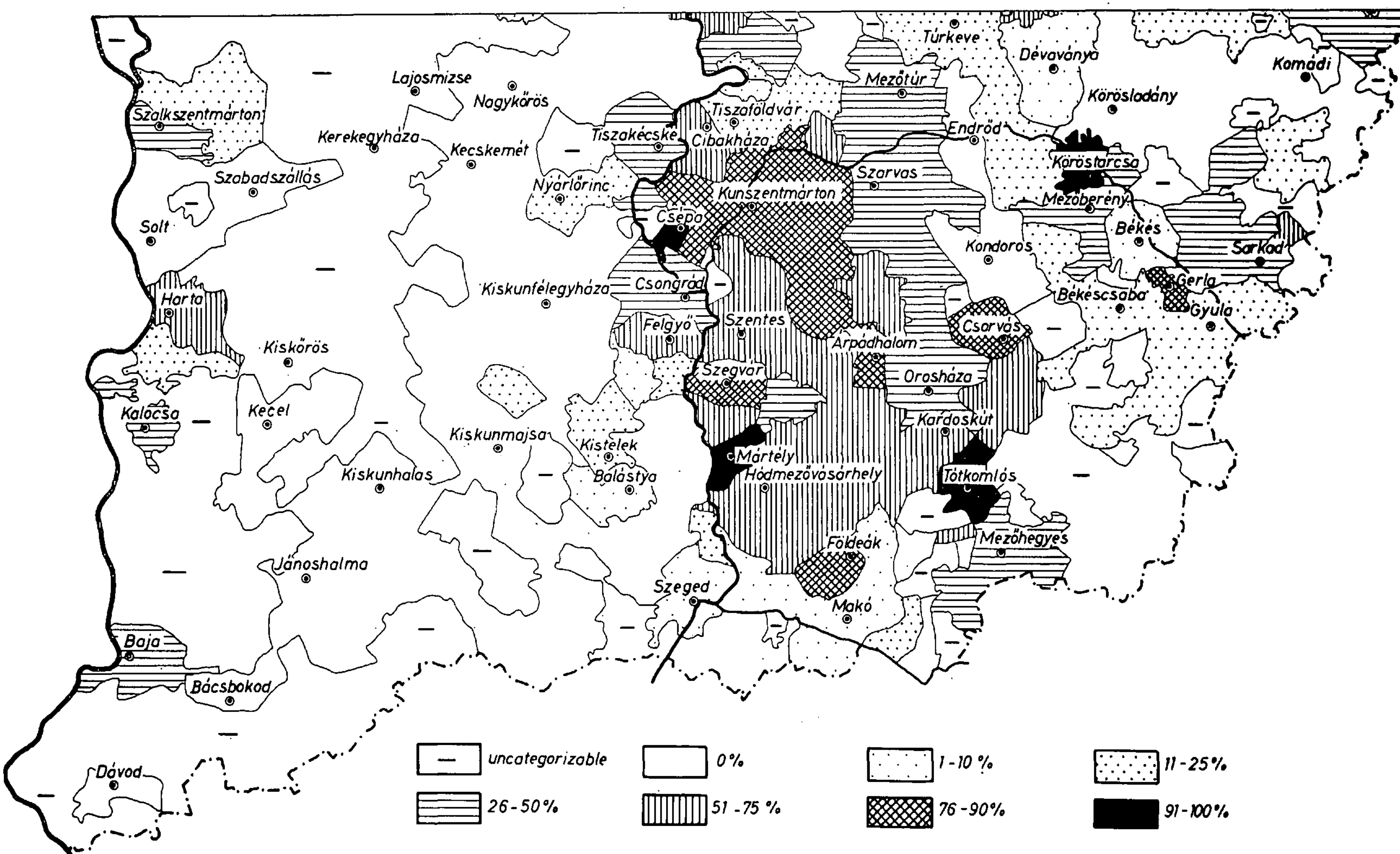

Fig. 5. Proportion of the gas-containing layer-water wells at a depth of 200—500 m

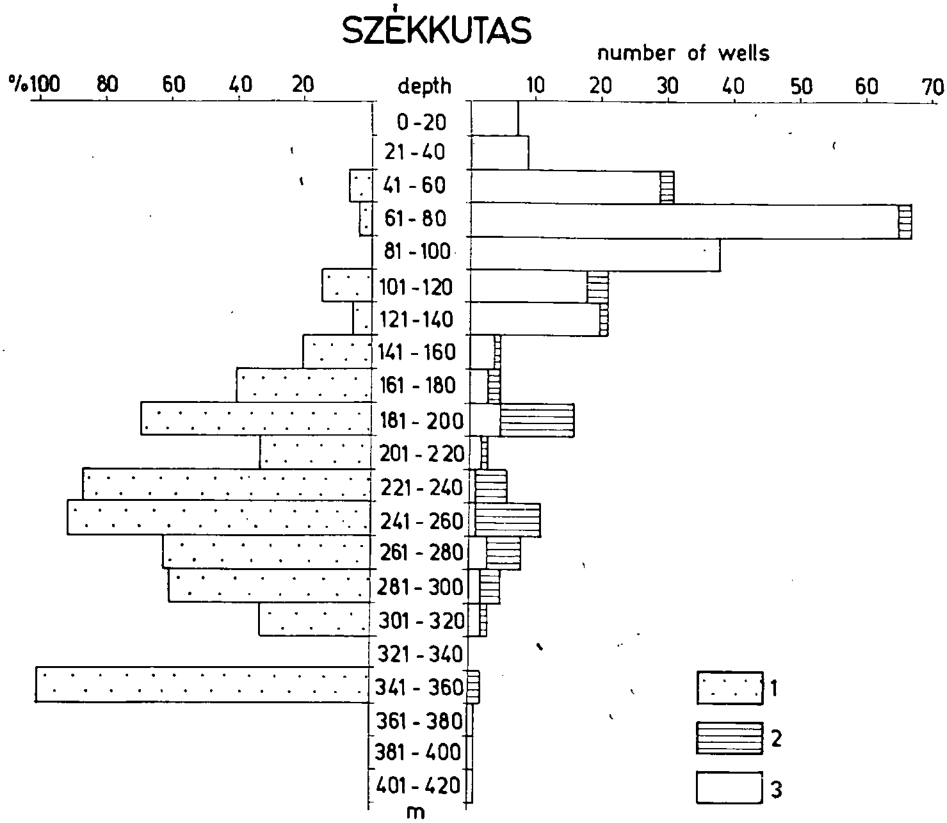

Fig. 6. Distribution by depth of layer-water wells of Székkutas
1 = proportion of gas-bearing wells
2 = gas-bearing wells
3 = not gas-bearing wells

From a comparison of Maps 4 and 5 it can be stated in generality that the proportion of gas-containing water wells on the southern part of the region east of the Tisza increases with the depth. Whereas at the 0—200 m level a value above 75% was obtained in only 4 communities, at 200—500 m the proportion of gas-bearing wells was 76—90% in 15 communities, and 91—100% in 4 communities. Although far fewer evaluable data are available for depths in excess of 500 m, it it appears that the occurrence of gas in the water-yielding wells is ven more general there. (For example, at Szentes 18 out of 20 wells contained gas, at Szarvas 12 out of 17, at Mezőtúr 6 out of 9, at Túrkeve 3 out of 3, at Mindszent and Tiszasziget 3 out of 5, at Békés and Gyula 4 out of 5, and at Fábiánsebestyén 6 out of 6.)

The vertical distribution of the gasification of the water-yielding layers is presented in the included graphical diagrams. The proportion of gas-bearing well increases uniformly downwards, e.g. in the cases of Székkutas and Szegvár (Figs. 6 and 7). Another type is represented by Hódmezővásárhely (Fig. 8), where the extent

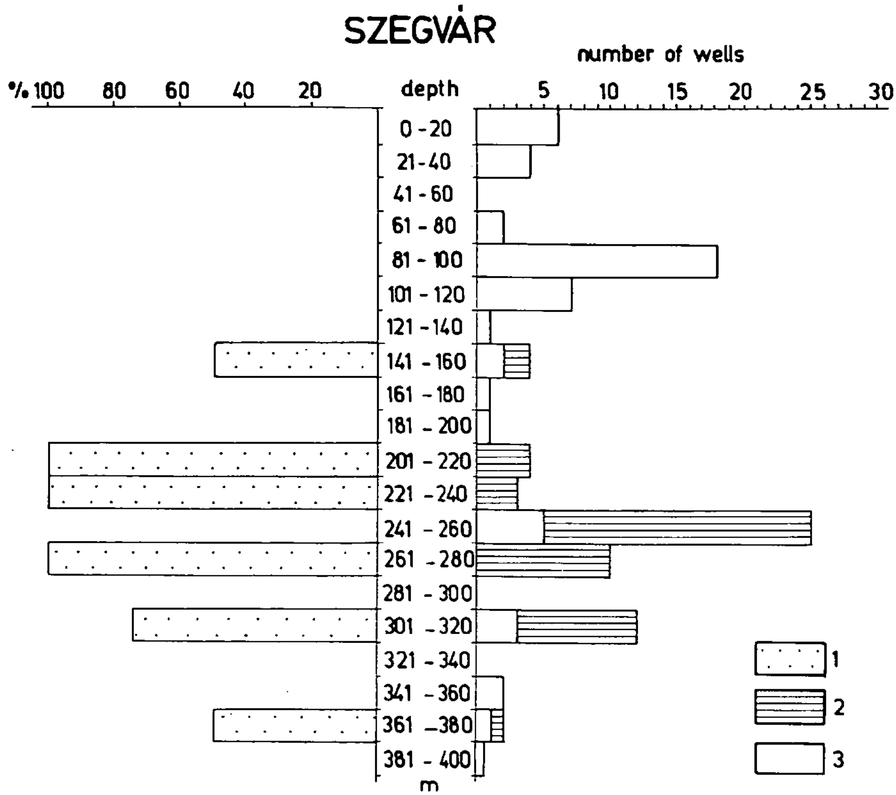

Fig. 7. Distribution by depth of layer-water wells of Szegvár
1 = proportion of gas-bearing wells
2 = gas-bearing wells
3 = not gas-bearing wells

of gasification first increases and then decreases as a function of depth. The proportion of gas-bearing wells barely changes vertically in the case of Tiszakürt, for example (Fig. 9).

There are some cases where only the uppermost water-yielding layers contain gas, gas production occurring only sporadically lower down. An instance of this is Kőrösladány, where the proportion of gas-bearing wells is 22% at 0—30 m, 6% at 30—200 m, and 0% at 200—1000 m. In such cases it is certainly the young marsh gas formed in connection with the processes of decomposition and carbonification of organic substances enclosed in sediments from the end of the Quaternary which comes to the surface with the well water.

A comparative analysis and complex natural graphical evaluation of our maps depicting the regional system of gas-containing water-yielding wells, in relation to geological facies maps, palaeogeographic, geomorphologic and tectonic maps, and maps indicating the chemical character changes and flow conditions of the layer waters is still under way. It is hoped that this work will bring us nearer to the clarifica-

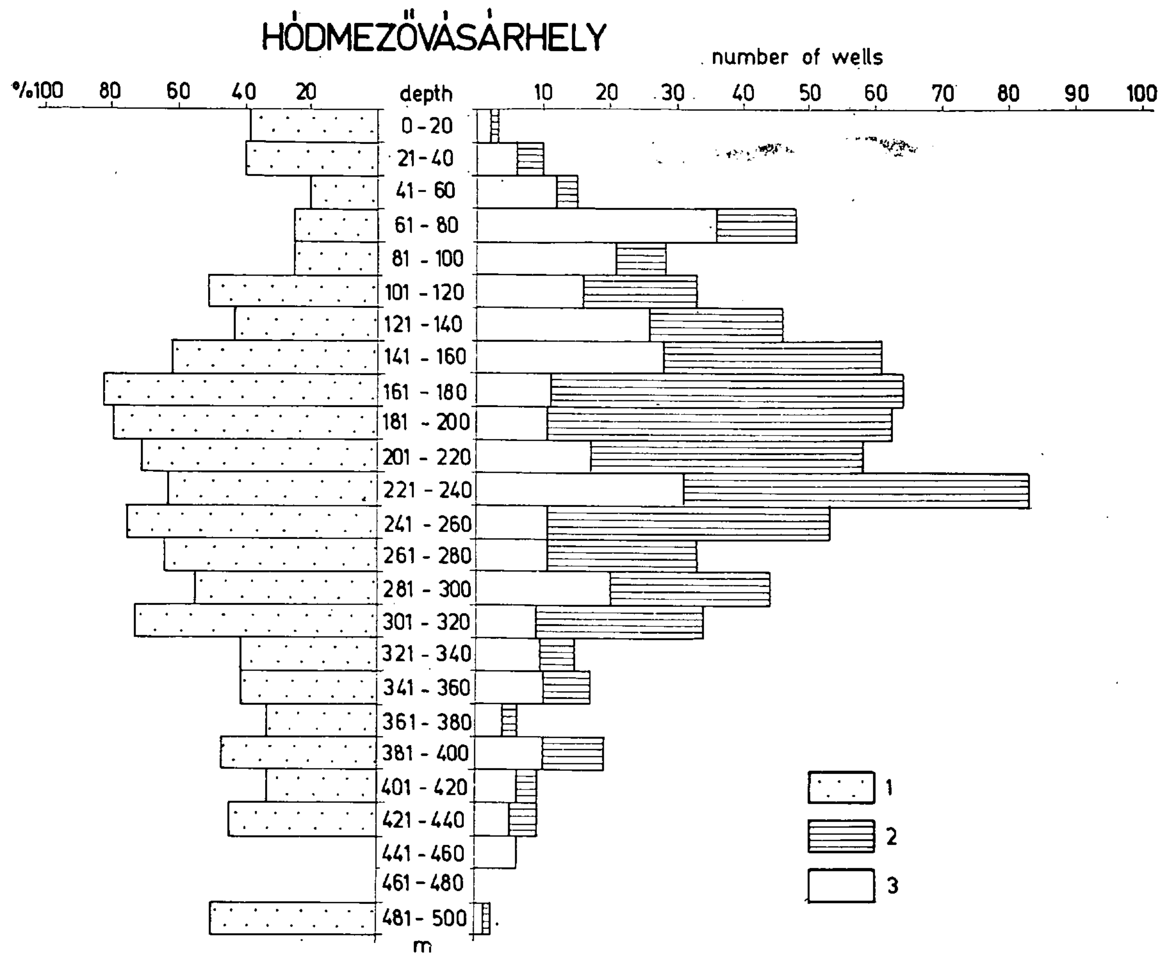

Fig. 8. Distribution by depth of layer-water wells of Hódmezővásárhely
1 = proportion of gas-bearing wells
2 = gas-bearing wells
3 = not gas-bearing wells

tion of questions of the conditions of occurrence of gas-containing waters, and of the origin of the gas. The results to date have encouraged the author to extend his investigations to the entire area of the Great Hungarian Plain.

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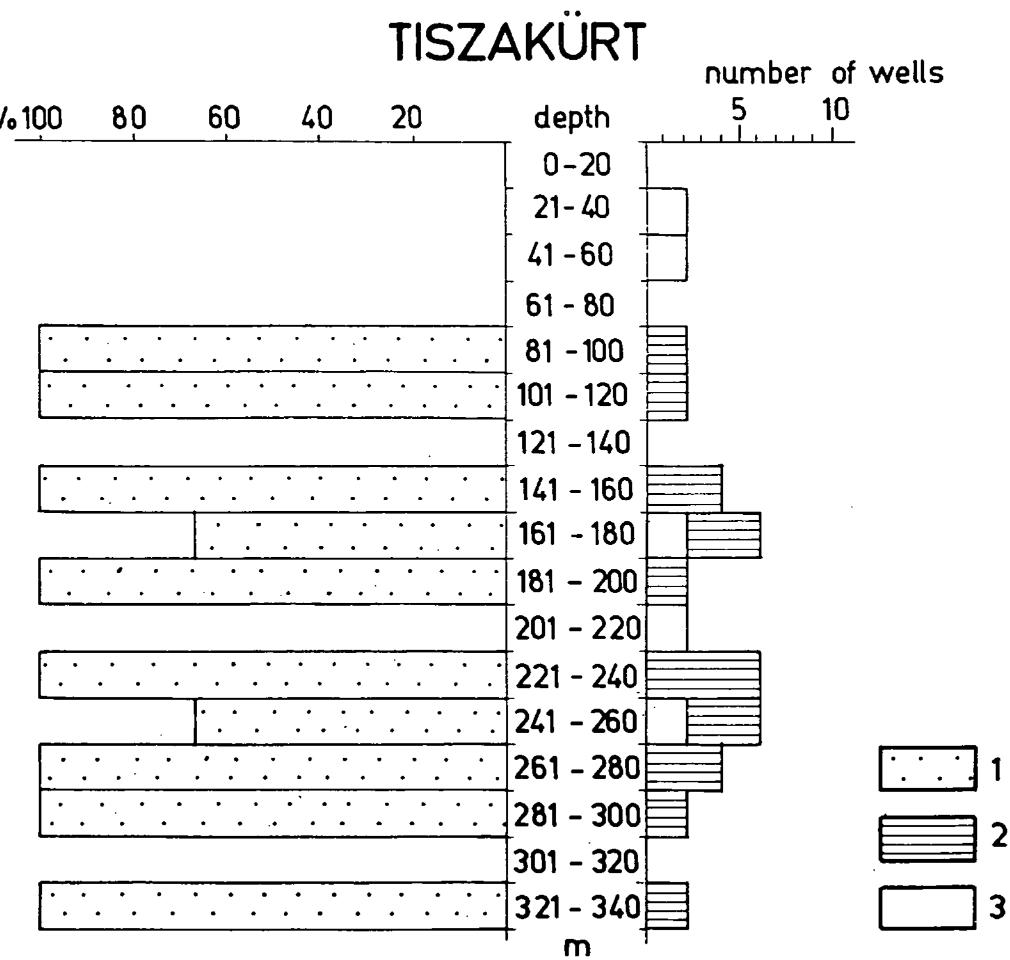

Fig. 9. Distribution by depth of layer-water wells of Tiszakürt
1 = proportion of gas-bearing wells
2 = gas-bearing wells
3 = not gas-bearing wells

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A UNIQUE LANDFORM: THE METEORITE CRATER

(A Plea for Wider Recognition in Geography)

GY. DOJCSÁK

There is an almost general agreement among most students of the surface of the earth, that the meteorite craters represent the most unique landform of our planet (and perhaps of all other planets with a solid surface). Yet, interestingly enough, no textbook in geography deals with this landform sufficiently. What is even more striking that most exts totally ignore it. It appears that most text writers are either not aware of the results of recent research in this direction (mainly by other sciences) or refuse to commit themselves — therefore selecting the ostrich tactics. This is unworthy to our profession and unfair to our students. Present day students are studying in an age when we are able to view our planet from the outside also and not only from the surface which gave a limited horizon.

The term "landform" in the title of course refers to "the shape, form and nature of a specific feature on the surface of the earth" (MONKHOUSE, F. J. 1965. p. 182.), that is also called terrain element, topographic relief or landscape features. It is well recognized that the earth's land surface is composed of a tremendous variety of landforms and known that their variety is endless since no two are exactly alike. The reason for this is due partly to their complex origin but mainly to the dynamic forces affecting them at all times. In spite of the limitless variety generally they are all regarded by most schools as the product of interaction between internal and external forces acting in constant opposition to each other. This is the stage of knowledge reflected by most introductory texts in geography today although this view reflects the knowledge of the early 1950s that is insufficient in the 1970s. It is not only insufficient but it is incorrect and wrong. Wrong because not *all* "... the features of land surfaces are the product of the two sets of forces" (MONKHOUSE, F. J. 1965. p. 48), but there is a third force. That force is *extra-terrestrial.* To date this force has been overlooked and unrecognized by most authors, although it has been active in producing landforms (minor and major) ever since the existence of the earth's crust. This force is the kinetic energy of cosmic bodies that is expressed by the formula $Ke=1/2\,m.\,v^2$, meaning that the kinetic energy of a moving body is one half the product of its mass and the square of its speed. Since the mass can range up to the size of minor planets and the cosmic speed is about 16 km/sec it is easy to see that we are talking here about tremendous (at the present time practically unexpressable) amounts of energies. The result of the impact of this kinetic energy is a surface feature what we call the meteorite crater. It is an impact crater that very much looks, like a raindrop created feature in loose dust in miniature, or in real size like an enormous bomb crater. To date, this landform has been most often referred to as "cryptovolcanic" or "pseudovolcanic" structure and has not been recognized by geographers at large as a valid, significant and unique landform.

The reasons for this are perhaps twofold: first, their origin had to be scientifically proven, and second, the old view concerning landform genesis would have need to be changed. Neither is easy and one cannot expect complete acceptance by all. But since the scientific proof for the meteorite crater origin has been established during the past two decades, a more general recognition is overdue and must follow.

Similarly to other modern sciences, geography and geomorphology (the true interpreter of landforms) must be able to accommodate new facts and change their views when old ones become restrictive. It appears that an increasing number of people feel the way as H. Robinson expressed: "... the whole approach to geomorphology is changing and many of the former explanations of features and processes are not only being questioned, but in some cases have been shown to be inaccurate" (ROBINSON, H. 1969. p. 111.). I like to regard the meteorite crater as a good example for pointing out not only that some explanations of features and processes must be re-evaluated, but also that a hitherto neglected landform should be recognized by geographers as well as by the general students of the surface of the earth. Reference to them in the past as "cryptovolcanic" or "pseudovolcanic" features reveals grave superficiality unacceptable anymore today.

It is quite probable that some readers have the impression that to regard the meteorite crater a "neglected landform" is unjustified. The reason for this probably is the fact that the meteorite craters have created fascination to people for a long time already. It is true, but the point here is not a reference to fascination but to scientific recognition. I would even like to suggest that the general awareness of them is largely due not to the meteorite craters on the earth but on the Moon.

The presence of well over 50.000 craters are recognized on the surface of the Moon (ranging up to several hundred miles in diameter) and a good many of them are widely regarded as meteorite craters, yet, how few of us are aware of the presence of similar features on the Earth? Many people are even able to name a few of these craters on the Moon, but on the Earth most likely, none. Or may be the Barringer Crater (Fig. 1) in Arizona, or perhaps the New Quebec Crater (Fig. 2/a), but quite likely no more. What is the reason for this? Is it because the Moon has many and the Earth only a few? Definitely not. It is quite probable that our planet was hit by an even larger number of extra-terrestrial bodies than our satellite was. The real reason for our unawareness of their presence on the Earth is very simple. Until recently selenography in some respect had a distinct advantage over geography. That advantage is mainly due to the fact that ever since Galileo's first telescopic observations in 1609, the major surface features of the Moon have been known, and many of the craters were recognized, while we had only a limited view of the Earth. (In fact the first detailed map of the visible side of the Moon by F. Hevelius, 1647, was a better map than any map of the Earth at that time.) However today we are able to elevate ourselves to have a birds' eye view of our planet making it possible for us to recognize the hitherto unrecognizable features. Naturally the surface of the Moon, being void of any gaseous envelope, lacks the gradational forces displayed so powerfully by our atmosphere on the earth. As a result, instead of having a relatively short period of existence the surface features are preserved and actually we can find the history of the Moon written upon its face. We recognized the bombardment of the Moon by meteoroids, comets, asteroids and even small minor planets a long time ago, and it was only a matter of time that man began to wonder why the same phenomena would not have taken place on the Earth. Especially

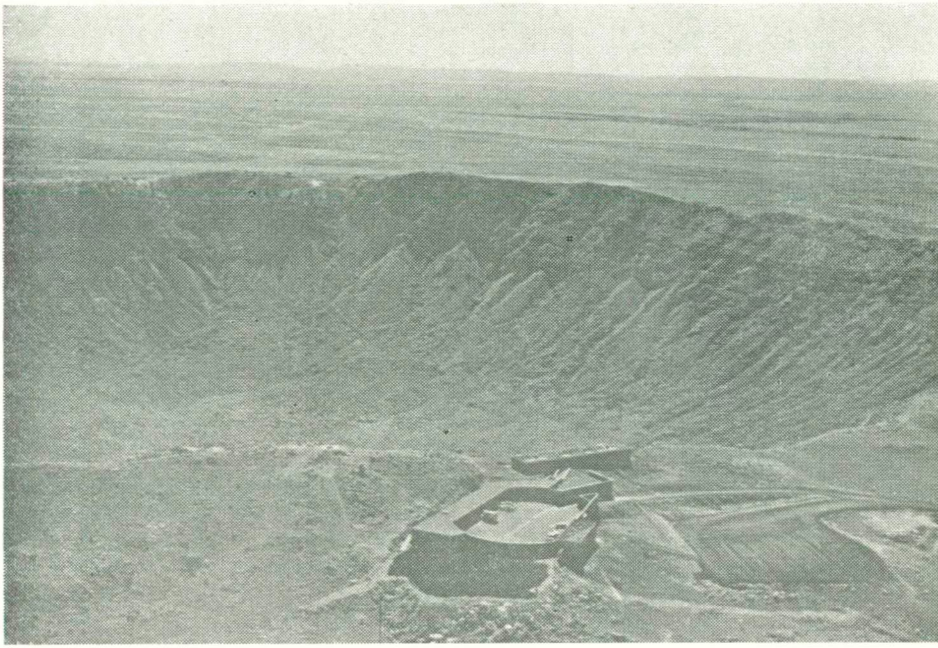

Fig. 1. The classic example of meteorite craters on the Earth is the Barringer crater in Arizona, USA.

considering its larger surface area and larger gravity, actually we may say the recognition of the meteorite craters on the Earth was inspired by the lunar features. (The similarity is shown on Figure 2/a—b.) However, recognition alone is not enough. Their origin must also be scientifically proven.

While the recognition took place at the end of the last century (Gilbert, 1895) the stage for thorough scientific investigations for most of these features was only reached during the last 20 years or so. Canada and the United States have played a leading role in these investigations by initiating the world's first systematic search for ancient meteoric craters, that has been followed by many other nations. As a result of these investigations, the acceptance of impact cratering on the Earth is gaining recognition.

Interestingly enough the question of the meteorite craters' recognition has not centered on disbelief in the existence of meteorites (because these have been recognized by the scientific community for about 170 years) but rather on doubts of their size being sufficient to produce large craters. Meteorites were known as very small particles rarely surviving the flight through the atmosphere to land on the ground. However, occasionally, they have been found and some of them proved to be of considerable size. (The largest recorded is almost nine cubic meters and weighs approximately 50 tons.) But even this size could not conceivably form features found on the surface of the earth ranging in size of not only a few hundred feet but up to dozens of miles in diameter. This leads us from the magnitude of meteorites towards that of asteroids and small planets. However with a magnitude of these sizes actually we are not looking anymore at impacts but rather at collisions.

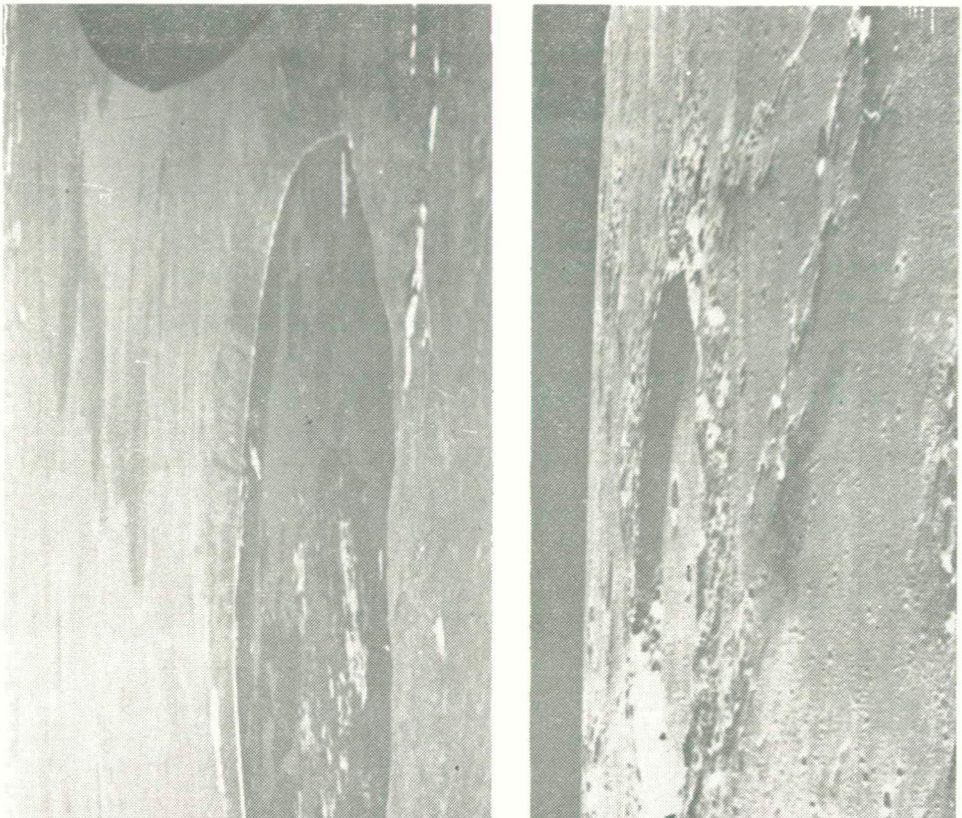

Fig. 2. The New Quebec crater in Canada (above) and the Marinus crater of the Moon (below)

Measuring by human times we may say that major extra-terrestrial objects are only rarely encountered by our planet (perhaps one in every 10.000 years or so) which is fortunate, but as a result their impacts are almost unobservable. But that does not mean that they don't exist. Their imprints are very much present on our Earth.

One of the major reasons for the delayed recognition of meteorites craters is the late realization of the fact that the failure of locating the mass of the meteorite, or at least fragments of it, in a crater or around the rim of the crater is of no proof against the impact origin. It is realized now that the reason for this is in the tremendous energy that is released by the explosion that evaporates, in some cases, the whole cosmic mass.

The explosion creates a depression in the earth's crust, that is a circular basin with elevated rims. To the early observers these features looked like volcanic craters. Hence the term "crater" and classification as a "pseudovolcanic" form. Later it became recognized that the implication of any form of volcanicity is misleading and unfounded. But how could the volcanic explanation be avoided if the only recognized process that supposedly could have produced such a form was volcanicity We have to remember that the "definition" still is, for most earth scientists, that landforms are the products of the internal and gradiational forces. For example, we may quote one of the most frequently used authors in North America on physical geography, A. N. Strahler. He divided the landforms into two main groups: the initial forms "are the original crustal masses raised by internal earth forces and by volcanic eruptions" (and the sequential forms "are the erosional and depositional forms made by agents of denudations" (STRAHLER, A. N. 1966, p. 261.). How do the meteorite craters fit in here? We have to admit that they do not. With all due respect to the eminent author we have to note his total omission. Undoubtedly the meteorite crater is a landform. Also, undoubtedly, it is an "initial form" but its origin has nothing to do with the internal earth forces and volcanic eruptions Not even with the struggle between the opposing forces, because only after genesis are they affected (similarly to every other land surface feature) by the gradational forces.

In the present plea for the wider recognition of meteorite craters as significant and unique landforms, I realize that some facts concerning their origin are perhaps not fully understood yet. But at the same time I also agree with what B. W. SPARKS said: "there are few, if any, landforms, the origin of which are known with certainty. The generally accepted theory is usually only accepted because it explains a large portion of observed facts than its rivals" (1966, p. 261.).

In the first half of the century the impact origin was regarded by some as a possibility. However, today their recognition is based on scientific investigations (topographic, petrographic, gravity, magnetic, seismic, structural and electric) and we have to admit that (while the evidence is unfortunately relatively little known) they are very convincing.

It appears to the author that originally not only the North American, but especially most of the European geographers were also opposed to the impact theory. For illustration it might be the faires (and perhaps also the safest) if I quote an authority under whom I had the honor to study. This prominent member of the Hungarian School, J. CHOLNOKY, expressed his view on the impact crater theory as: "a total humbug and the acceptance of it indicates an inexpressable degree of ignorance... it is a shame that some of our scientists are even considering it seriously" (1942, p. 355.). He said this in 1912 after visiting the then only known meteorite crater in the world, the Barringer Crater in Arizona. And what he said was actually the general view of the time not only in Europe, but everywhere in the world. As a result of that view still even today we can look into any textbook onpphysical geography and we find that the meteorite craters are left out (for example, Gresswell of England, Louis of Germany, Markov of the Soviet Union, Powers, McIntyre, and Strahler of the U.S.A.).

The situation is different with American geomorphologists. Credit has to be given to Lobeck (the great delineator of landforms) who in 1939 already included in his text a small chapter on "supposed meteorite craters" (LOBECK, A. K. 1939. p. 171.). But he still treated them with caution and suspicion. A. D. HOWARD and L. E. SPOCK (1940, p. 332—345.) deserve even more credit for including the meteorite craters in their landform classification as being of impact origin — but, obviously lacking sufficient scientific proof at that time yet, they have not been taken too seriously and became disregarded by most authors in geography. The classic example of meteoric craters (the Barringer) is mentioned in Von Engeln's book of 1942, yet, in his landform classification that is according to him "forward looking and comprehensive" (VON ENGELN, 1942. p. 69.), they are not included. Strahler in the "Eart Sciences" recognizes them on the moon (STRAHLER, A. N. 1963. pp. 83—86.) but is not very convinced of their presence on the earth. He does not mention them in his later (1966) publication "Physical Geography". W. D. THORNBURY, 1954. p. 515.) is one who among the geomorphic processes includes the extra-terrestrial process, and who took a stand on meteorite craters as being of impact origin. However he discusses them under the title "pseudo-volcanic features" at the very end of his book, almost like a leftover, together with salt plugs, bomb and mine craters. Unfortunately in his book he did not include a landform classification, therefore, his "commitment" may have a shade of doubt. It might be of interes to point out here that the cited geomorphologists are with a basic geological background. If we look into the writings of geomorphologists with a more geographical education, for example, such as Wooldridge or Morgan the omission is obvious (WOOLDRIDGE, S. W. and R. S. MORGAN, 1959.).

The suggestion here is not that geologists on the whole accepted the presence of meteorite craters on the surface of the earth, while the geographers ignored it, because that is not the case. But it appears that the geologically trained geomorphologists had a more open attitude towards this unique landform.

From a survey of geographical literature (limited as it might be) it appears to the author that the meteorite craters as surface features have been neglected by geographers. This landform in some cases may range up to many dozens of miles in diameter. In addition to size is very possible that they may have some mining and recreational possibilities as suggested by DIETZ (1961) and others. Obviously they cannot continue to be overlooked by professional geographers, teachers, and students.

Interestingly enough at the last (22nd) International Geographical Congress (Montreal, 1972) there was only one paper submitted that dealt with the meteorite craters (and in the Congress volume even of that only the abstract was printed) while in the volume of the last 24th International Geological Congress (1972), tha was also held in 1972 in Montreal, a dozen articles dealt with them, obviously indicating the difference in interest. Perhaps it is not unrelated to note that if we look into the "Encyclopedia of Geomorphology" (1968) the meteorite craters are not discussed there, instead a reference is made to "The Encyclopedia of Atmospheric Sciences and Astrogeology". In other words if someone at the present time is interested in this landform or surface feature the explanation of it is not in geography or even in geology but in atmospheric sciences and astrogeology. The point here is not to question the relationship of meteorite craters and astrogeology but to indicate the absence of discussion of a landform in geography.

Today meteorite craters are known and have been studied in many parts of the world such as Canada, U.S.S.R., U.S.A., South Africa, Australia and Europe. The number of the proven ones is around 60 already and the number of the probable and suspected ones are over a hundred. Undoubtedly, as investigations continue, more and more will be recognized on the surface of the Earth. As mentioned earlier it is suspected that their presence in some places may have economic significance in mining and tourism. But their are perhaps even more significant on the buried erosional surfaces. We have every reason to suppose that in earlier geologic times of the Earth cosmic wanderers in the solar system were even more numerous and collisions or impacts were more frequent and of greater intensity than at the present time. Taking this into account the paleo-geographers also have to account on buried erosional surface for the presence of meteorite craters, or rather (as DIETZ, R. S., 1961), named the infilled ancient features) Astroblemes (Fig. 3). The writer has used paleogeographic interpretations for many years in oil exploration and at times pondered over the presence of sub-surface features that would be rather difficult to explain in any other way. It appears that oil production from a Wester Canadian field is related to impact cratering (SAWATZKY, H. B. 1972). The Sudbury Structure of Canada is believed to be more and more the result of a large meteorite impact (FRENCH, B. M. 1972, p. 125) and the huge nickel and copper reserve the result of it. The Vredefort Structure of the South Africa with its gold and diamond accumulations is strongly suggested by some (DIETZ, R. S. 1961) to be of an impact scar. All these are indicators of not only their presence but also their related economic significance.

L. KING (1967) wrote that: "It was necessary for the author to see as much of the Earth's surface as possible, yet not to interpret it in terms of preconceived philosophies; often to sit passively upon hills just letting the scenery "soak in" and teach the „beholder". This kind of stand against "preconceived philosophies" is encouraging when we seek to find order, system and possible explanations amidsthe topographic features. There is no more question about the existence of the meteorite craters on the Earth. They do exist and have to be dealt with in geography. In order to do this we have to recognize that:

1) Meteorite craters are unique because they were formed by a process not similar to the genesis of any other landform.
2) The meteorite craters are produced by the impact and the accompanying explosion of extra-terrestrial masses.
3) The resemblance of meteorite craters to volcanic craters is only superficial.
4) The possibility for meteorite crater formations on the surface of the Earth existed since the first crust was formed.
5) Their presence can also be suspected on buried erosional surfaces.

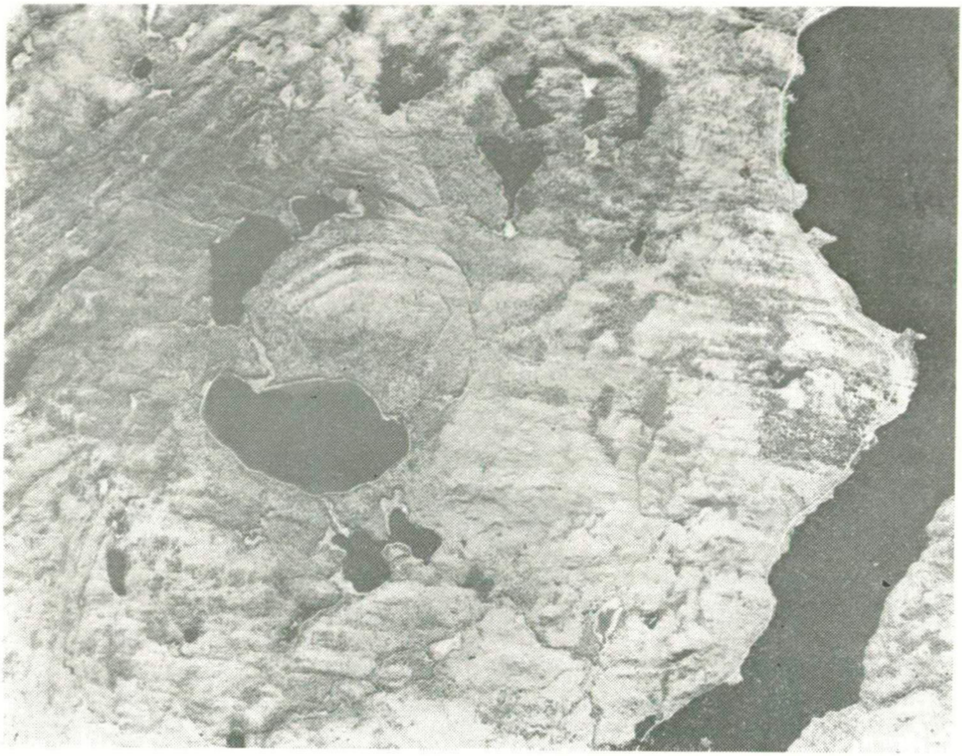

Fig. 3. The partially exhumated Brent crater (Ontario. Canada) is a good example of the astroblemes

6) The presence of meteorite craters on the surface of the Earth (and their range in size) is qualifying them from both minor and major landforms. It is necessary to regard them as extra-terrestrial (cosmogenic) landforms, which were not produced by tectonic, volcanic or gradational forces, but by cosmic forces.

On these grounds, it is proposed that they should be included in the classification of landforms in the:

a) surface forming processes (internal-external and *cosmic*),
b) classification of basins; on the basis of origin, form and size,
c) classification of lakes (besides the most important categories produced by erosion, deposition, earth movements, volcanic activity),
d) form and structure modifying forces of rocks (besides tectonics and weathering).

Until these are not recognized by geographers and included in our textbooks on physical geography, or in any other text on the earth sciences, at least as possibilities, our competence is questionable and the students of geography have every right to say that the book we make them to buy is 20 years out of date.

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THEORETICAL AND METHODOLOGICAL PROBLEMS OF ECONOMIC REGION-SCHEME OF HUNGARY

GY. KRAJKÓ

Areal distribution of Hungary was worked out by JATE Geographical Department during the past years. We think it necessary to give a summary of the principal and methodological questions denoting this problem. Later, in the next volume of our magazine we are going to touch the actual results of our researches, i.e. we shall go into details about the areal distribution.

The principle of the Integrant Areal Unit

Economic regions are areal units resulted by the social division of labour, which exist objectively, which specialize on the basis of favourable social and economic fundamentals, but which have complex characteristic features too at the same time. Consequently they have inner and outer traffic connections, therefore the narrow of the regions are the areal complexes of production, they have regions, they are separate units as far as the sequence and direction of their development is concerned, therefore they can be the bases of the regional research and regional planning.

The enumerated characteristics and functions cannot be accomplished by the region-branches one-by-one, they do not form complexes of production separately, very often they are not even in areal sequence. E.g. an industrial region has different role and areal existence from an economic one. The integrant economic units cannot be considered merely as the amount of the branch regional units, because the formers — and it is obvious from the definition — have considerable different qualities.

In foreign technical literature the economic regions usually have different names. E.g. in the technical literature of the western countries (mainly in the French, English and West-German ones) they call the region a planning centre but we come across the expression region, too. In these cases the authors mean areal units or they just denote a region on the basis of the different degrees of mobility of the population.

The name region was used by a lot of Hungarian authors, too. These authors meant the economic regions of towns and villages, even when they took into consideration various other factors of social and economic life. We have to emphasise the difference between economic regions and regions because they are essential areal and functional differences between them. The basic definition of an economic region is very important because the various differences usually cover different research methods.

The most important characteristics of economic regions

The differences in the various definitions and the different terms used in foreign technical literature obliges us to give a short summary of the most important characteristics of the integrant economic regions:

1. Economic regions as areal units of the social division of labour exist objectively; consequently their borders are objective, too. The development of the social division of labour has a new form with the extension of the production of goods, i.e. economic regions are formed. This objective course is very important for us because this is the basic formula in defining the borders of an economic centre. The borders of an economic region cannot be designed by or identified with the network of settlings; they must be researched.

In contrast with administrative borders, the borders of economic regions are regional. E.g. in the case of microregions the considerable decrease in the social and economic courses and their sudden increase mean a new economic border.

The development of economic life causes changes in the areal connections and these changes have their effect on the borders of regions. Therefore, when defining a new border, we have to take into consideration the tendency of the development as well as its effects.

If we accept the objective existence of economic and social courses (which form the economic regions), we have to accept the principle of the objective existence of the borders, too. But even if we accept these principles we must be flexible when we define the borders, because they "hide away" from the explorers especially when they want to define them on a high level. To avoid being inflexible we ought to try to define the areal differences of the economic and social courses in the smaller units of the social division of labour and this will be the basis of our definition. In this way we can define a lot more micro-regions belonging to different centres. Unfortunately the results led us to the conclusion that we must be even more flexible when defining the borders of economic regions because there are areas which do not belong to any economic region.

Productive areal complexes can be defined and they are very important. Peripheral settlings which are affected by various factors are of less importance.

2. The specialization of the regions: the regions are different as far as their social, transport, productional, etc. fundamentals are concerned. Therefore, in the corresponding geographical division of labour one can find essential areal differences. These differences are expressed by the different productional profiles of the regions. Specialization is a very important step in the formation of a region and it is caused by various productional branches. Consequently, specialization is not a constant category, but it follows the above-mentioned course and expresses a dynamic development. Those who use only one formula in defining the different industrial branches which belong to the specialization of a region in order to be exact simplify reality and show only one or two, but mainly quantitative, characteristics of the course.

We can observe three different levels of specialization:

a) specialization of factories,

b) branch specialization,

c) the specialization of the integrant economic region.

We must emphasize the fact that the difference between them is not only quantitative but also qualitative. For example, branch specialization is not simply the mechanical sum of factory specialization. Similarly, the branches forming the profile of the integrant centre have more important and complicated functions. Therefore, the factors which contribute to the definition of branch specialization cannot be used on a higher level.

The branches which belong to the specialization give the majority of the industrial and agricultural production in a given region. These branches are very important in the structure of the region, they define the tendency of the development, they affect the other branches and they form the basis of foreign trade. All the branches which have considerable proportional rates in relation to the production of the country and the region, in foreign trade, which have centre-forming powers, which contribute to the principle "minimum labour — maximum production", belong to the specialization of the region.

Specialization, in some respects, is limited in the micro-regions because it represents only a certain part of the production profile of the mezo- and subregions. On the other hand, it is extended because certain branches are of great importance in them. Similarly, the number and the proportion of the branches is different, too.

Quantitative descriptions of specialization, cannot be perfect, and the smaller the area is the less perfect the descriptions will be. So the data referring to this can only illustrate the point but cannot enlighten the deeper connections. The quantitative side on its own cannot be used even to describe the fact of the specialization at times. Therefore we must research the function of specialization, too. The problems of the function of specialization are as follows:

a) What is the role of specialization in the regional complex of production.

b) What are its natural and social conditions.

c) Does it correspond to the tendency of the development of the given region and what is its role in it.

To research the above-mentioned problems is a very important part of the research of the regions and leads us to understand the essence of the region.

3. The complexity of the economic regions: Economic regions not only specialize but they are complex, too. During the past decades there were serious debates in our country, too, about how to interpret the complexity of the regions and the debate is still going on. It is an accepted fact that in the development of the economic regions, besides developing the branches which contribute to the specialization, it is very important to develop the supplementary branches, i.e. the branches of local importance. But the most important part is, to create possibilities for the complex development.

We interpret the complexity of the economic regions as follows: the proportional development and the inner connection of the production branches within the region must be guaranteed, every source must be tapped, and the development must contribute to the principle "minimum labour — maximum production".

From the definition it is obvious that the complexity is the main demand in every taxonomic unit of the regions. But its effectiveness depends a great deal on the number of the economic branches (first of all branches of industry and agriculture) and their development level.

4. Regional production complexes: The production structure of the integrant economic regions consists of branches belonging to the specialization and branches belonging to the complexity. We can only see a theoretical difference between them because they arein close connection with each other as far as the area of the production, the natural resources, and the areal production complex of employment are concerned. The areal production complexes mean the essence of the economic regions, without them the parts of the integrant region lose their importance. But we have to understand that even if we take into consideration all the production connections we cannot define the economic region properly. Since the latter is not only a production but also a consumption unit, and it contributes to the development of the social courses and to the manifestation of other characteristics of human life. These connections have special importance within the micro-regions. To research these problems could lead us to the problems of attraction.

The skeleton of the regional production complexes are given by the branches belonging to the specialization and of course they define its character, regional expansion and its economic connections. Branches which do not belong to the specialization are also parts of the production complex and they contribute to the economic structure of the region together with the above-mentioned factors.

The types of the regional production complexes are different in Hungary, some parts have their effects on other branches belonging to other regions. To define the border is very difficult as for example the aluminium complex has a great deal of sub-centres and mezo-regions. It is only the food production complexes that remain micro-regions and stay within the border of sub-regions.

5. The connection between the branch regions and integrant regions: It usually leads to misunderstandings if we take into consideration the different systems of the branch regions when defining the borders of the integrant economic regions. It is an accepted fact that the branch region and the integrant economic region are two different regional units. We come across this problem when defining the borders — the problem is which branch is the dominant one.

As we have already mentioned it is the leading branch that gives the tendency of the development in the formation of the regional production complex. In most cases this leading branch is industry but the role of agriculture can be important, too. Therefore in industrial areas we emphaise the prominence of the industry and obviously agriculture has the dominant role in agricultural areas. To define the borders of micro-regions we got important information by analysing different types of settlings formed by the mobility of the population.

When defining the tendency of the development, the dynamism and the development level of the centres all production branches were taken into consideration.

6. Connection between the settling-network and the economic regions. The traditional hierarchy of the settling network which developed during the centuries of past history has this hardly visible effects on the whole region of the region. Making these effects visible we can see, that the effectiveness of these connections vary depending on the function of a certain settling referred. To research the attractivity of the settlings is the most important base in denoting the borders of a region. It can help especially in the case of settlings being far from the middle of the region. This cannot be taken as by chanche as the attractiveness of the settlings reflects very important economic, social and cultural connections. In connection with the settling-network there are two questions of special importance:

— the role of the centre of economic regions,

and

— a certain degree of importance of the attractiveness.

Each grade of the economic region has its own economic region. The region without an economic region cannot be called economic region proper. But this does not lead to the fact, that the economic region proper can be called the attractive centre of the regions.

This problem is especially of great importance in the case of micro-regions, because in this particular case there is sometimes an areal covering as far as the attractiveness of the region and the micro-region are concerned, and ,while denoting the borders of a centre, we often refer to researches concerning the attractiveness of the regions. In spite of all this, confusion between the two items should be avoided.

a) The contents of the economic center differ from those of the attractiveness: the former being far more rich. In the case of the former it is the characteristics, the capabilities, the productivity of the productive branches as well as the connections of the economic and social life that are the most important, while in the case of the, latter it is only the connections of the economic, social, and cultural life that are summed up.

b) In respect of the function of the economic region it is a regional production unit. For various reasons the region of attractiveness cannot be called a regional unit.

c) The regions of attractiveness can undergo various changes without affecting the borders of the economic region (e.g. replacing a controlling unit, building a new type of school, operating a bigger department store, and so on). The corollary of this statement is not valid.

d) There is more than one region of attractiveness within an economic region and these are in subordinate relationship with one another. However, sometimes regions of the same size can be found. Therefore we cannot speak of two different systems.

e) There is a closer connection and a closer dependence between the of attractiveness and the administrative system (e.g. controlling functions) than between the economic and the administrative system. The former goes beyond the administrative border as far as its elements are concerned (e.g. education, health, and so on), while the latter goes beyond the administrative border to an extent which is able to change the whole system.

These differences do not mean that there are no common elements in the two factors. Especially in the case of micro-regions one can find very important similar characteristics, both being the regional form of the economic and social activity, therefore a number of characteristics change in proportion to the distance from the centre denoted by the possibilities of transport. This similarity can be the basis and the most important element in defining the borders of the micro-regions paying attention to the centres of attractiveness.

The centre-forming role of the regions is different depending on their taxonomical grades. It is strongest in the case of the micro-regions and it decreases in the case of larger units. That is why the attractiveness of the regions in the case of the micro-regions has a more important role than on higher levels while denoting the borders.

During the course of the research we worked out three different grades of the system of attractiveness of the settlings. We want to use these three different grades when denoting the micro-, the sub-, and the mezo-regions. The hierarchy of the settlements was taken into consideration not only in the case of denoting the borders of the micro-regions but also in the case of the next step, i.e. when uniting the micro-regions into subregions, as well as when proving that all the subregion belong together.

7. The connection between the population and the economic regions. Population is regarded as the most important force of production by the economic geography. Therefore we need especially the connection between the population and the economic life. The different regional development of the branches of the people's economy causes changes in the composition of the population, it also has an effect on the migration, it effects the tendency of a number of important demographical phenomena, and, the population as labour force effects the development of the production branches of an area. This well-known scheme makes its way very differentially as far as the given region is conderned.

Phenomena in connection with the population such as regroupment, wandering, migration, the increase of the number of the population, or a sudden decrease, etc., take place within the borders of the micro-regions and are caused by the regions, by their power, and they change in proportion to the distance and the possibilities of transport. The tendency and the intensity of this change can be measured and summed up mathematically. The factors gained in this way can be used when denoting the borders of the micro-regions as well as when analysing some other problems.

We drew maps of the above-mentioned elements of the population and we achieved a complete map of the mobility of the population by uniting the maps of the elements. This map helps to denote the regional structure of the regions, the peripheral area, and it helps to analyse the contents of the regions.

8. The effect of the physical geographical factors: the effect of the physical geographical factors can be traced in the regional situation of the forces of production and in the regional situation of the economic regions in Hungary, too. (Especially in the case of the macro-regions.) The similarity between the division of the landscapes and the economic region system is not gratuitous. When denoting the border of the economic regions the difference in the physical factors as well as the similarity of these cannot be a matter of argument but it is an accepted fact that the economic regions which are different from one another have different physical geographical bases too (e.g. relief, soil, minerals, etc.). Therefore while analysing the regional production complexes it is very important to analyse the physical geographical capabilities of an area even if these capabilities are not of major importance when denoting the borders.

To analyse the physical geographical capabilities is very important in each grade of region, partly to denote the border of the centre and partly to analyse the possible tendencies of development. While denoting the borders of the micro-regions the physical geographical factors as an important factor were considered to be of major importance.

9. Taxonomical structure of the regions: To deal with this problem is very important for us because:

— plans made in Hungary are different, i.e. they use them in different ways, that is, the meaning of a certain taxonomical grade is different in each of them:

— when denoting the inner structure of the regions, first the system to which they belong and the role it has in the system must be defined. The method we used while denoting the borders of the regions, (mounting from lower grades to higher ones) demands the clear interpretation of the taxonomical grades as well as the analysis of their connections and laws.

Regional distribution of social production produced different grades of economic region. During the development of these grades we must take into consideration the conditions and capabilities which give particular characteristic features to the course and lead to essential differences in each area — with special regard to the taxonomical units of the regions. The economic region if separated from the others loses its significance. It has a special role, its functions are significant only in the very system where it belongs. Therefore the analysis of the position of the taxonomical units cannot be done separately, we cannot set up absolute standards because the fact that the centre belongs to a certain unit depends not only on its inner proportions, size and level of development but also on its relationship to the other regions.

The differences among the grades of centre can be denoted on the following basis:

— the function, size, proportion and number of the production branches which form the specialization, also their place in the system of the region:

— regional production complexes,

— productional, trade, and transport connections,

— the tendency of the region, the identity and the size of the economic and social problems in its development,

— demographical problems (birth proportion, the migration of the population, the distribution of the population, labour force resources, etc.) similarity and size,

— the region of attractiveness of cities, their functional grade,

— the effect of the natural capabilities on economic life.

Taking into consideration the above-mentioned factors on the basis of our research material we denoted as well as working out three taxonomical grades:

— *micro-regions:* the smallest regional units of the geographical division of labour which have the most important characteristic features of the integrant economic region.

The greatest unit which is still a micro-region can be denoted by the role it has in the geographical division of labour and it does not depend on the size of the area. The micro-regions, although they are part of the country-wide division of labour, accomplish this role through a series of link transmissions. In most cases the integration of more than one micro-region forms a larger production complex. So the size and the magnitude of the micro-regions are defined by the regional differences of the economic and social courses of a centre belonging to a higher level.

In the case of micro-regions the economic as well as the transport connections are limited so the possibility of prosperous connections among other economic units of the same level is out of the question. In the case of subregions these connections are possible, in the case of mezocentres these connections obligatory.

— *subregions:* the system of the micro-regions is connected with the mezoregions through the network of the subregions. One can find a lot of similar characteristic features between the micro-regions and the subregions both of them being the objective, regional unit of the division of labour. The subregions consist of micro-regions therefore the outer borders of the latter cover the borders of the former. This hierarchy of centres can be used to denote the higher grades. From the above-mentioned facts it follows that both of the grades have the basic characteristic features of the integrant regions and each of them has its own peculiar inner economic and social rhythm of life.

Besides the similarities a lot of differences can be enumerated:

— the micro-region is the smallest unit of the division of labour, the subregions is more compound, its area is greater, it represents a higher level in the division of labour, therefore there are differences in the basic characteristics of the regions,

— the basis of specialization in the subregions is richer, wider and more compound,

— the regional production complexes contain more branches and are on a larger area than in the micro-regions,

— the outside productional, transport connections are wider, they can be called country-wide,

— it has peculiar development capabilities and tendencies and problems of development which, although they contain them, cannot be called the mechanical sum of the similar factors of the micro-regions, because they are on a more general level,

— as for the functions of the regions of the subregions, they are richer but in spite of this they do not necessarily cover the whole area of the subregions. From this follows that their effect on the inner economic and social courses is smaller (these courses do not always follow the tendencies of the centre) therefore their significance in denoting the borders is more limited than in the case of the micro-regions. The region-forming power of the regions in the case of micro-regions affects a smaller area but it has a close effect on the borders of the regions.

Why are the subregions considered to be a very important link between the micro- and mezo-regions?

— The differences between the tendencies and the levels of development are very big among the micro-regions and they are represented in the subregions,

— there is not a close connection between the mezo-regions and the peculiar economic and social courses which take place in the micro-region; they meet in the sphere of the subregion,

— the subregions are quite homogeneous, they have their own peculiar characteristic features, tendencies of development, similar rhythm of life. These factors can hardly be found in the mezo-regions,

— the regional differences within the mezo-regions are expressed by the subregions, in the case of micro-regions they are not significant,

— by denoting subregions we can eliminate the taxonomical differences among the various schemes of regions (e.g. the area between the Danube and the Tisza, the middle-Tisza area, south-west Transdanubia, etc.). On the other hand it can help to denote the mezo-regions and they are very important in denoting the administrative distribution and the unity of the economic regions.

The subregions exist objectively, they are regional units which have the most important characteristic features of the integrant economic regions, such as: they specialize, they are very important parts of the country-wide division of labour, their regions are the regional production complexes (as most important centre-forming powers), they have the peculiar conditions necessary for the economic and social development, so the tendency of their development, the problems of their development, are different from those of the other regions, they have economic regions, the attractiveness of which covers the whole area.

We do not give a detailed characterisation of the mezo-regions as the above-mentioned characteristic features of the regions can be applied to them, too. (The definition of the of the region, the question of specialization, the regional production complex, etc.) We only remark that the unity of the subregions within the mezo-regions is loose sometimes and that in this respect there is an essential difference between the industrially-developed and -undeveloped areas as well as the industrially non-developed areas. E.g. it is easier to prove that there is a difference between the county of Békés and the area between the Danube and the Tisza, and they each represent a subregion, than to prove the fact that they belong to the same mezo-region.

A general law in the taxonomical hierarchy of the regions is that the factors which represent the unity of the higher levels have smaller effects, but in the case of the lower levels the effects of the factors are stronger, i.e. the economic units of higher levels are less homogeneous than the lower taxonomical units.

10. For the essential analysis of the economic regions it is of basic importance to define the pace and the level of the development, because each of the regional units has its own peculiar dynamics of development.

11. To denote the factors belonging to the peculiar development of the economic regions. Economic regions are different from one-another not only in the magnitude of their development and the tendency of the development, but also in the fact that each of them has its own tendency of development, and, of course, special problems of development in close connection with all this. In a number of cases similar tendency of specialization comes true in very different ways as wel as it can demand various deeds. E.g. in the case of both subregions — the area between the Danube and Tisza and county Békés the main tendency of the development is to develop the agriculture. But in the area between the Danube and the Tisza — which is actually known as grape and fruit-growing area — and consequently it is the connecting industrial branches that are of especial importance; while in the county Békés it is the maise and corn-growing as well as swine-breeding that are the main branches. The two different tendencies lead to different problems, which are present in the regional plans, too. Similar examples can be found in the case of most of the regions which on one hand reminds us of the importance of the fact that while denoting the borders the peculiar tendencies problems of the development must be taken into consideration, on the other hand the demand of the latter can be fulfilled only if the aims of the plans made for a period of medium length are taken into consideration.

Problems Resulting from the Peculiar Distribution of the Forces of Production in Hungary

There are general laws known of the development of the social division of labour, but these laws are fulfilled i.e. come to existence among practical circumstances. From this it follows, that the principles and methods in connection with the economic regions are general on one hand, and, which can refer to all the socialist countries, on the other hand there are a lot of questions which are raised by the peculiar characteristic features of a given country.

When denoting the economic regions of Hungary, the following characteristic features must be taken into consideration:

a) Besides the fact that the industry is highly centralized and regionally concentrated, the transport-network is highly centralized in the country, too. Budapest has an overpowering effect both economically and intellectually in comparison with the other towns in the country, it has a country-wide attractiveness. As a result from the fact that the production trade is highly centralized, the connection of the centres belonging to the higher level and the Centre are strong, while the connections between one another are very bad. Consequently the connections with the Centre are intensive, while the ones among one another are in most cases of "non-important areal" which make it complicated to denote the border of the centres.

From the centralized characteristics of the economic life it also results, that the taxonomical grades are almost impossible to analyse in our country, because there are only slight differences among the certain grades in the Central region. Therefore while denoting the taxonomical grades the Central region is advised to be dealt with separately.

It is a well-known fact that in our country the economic and the administrative units do not correspond either horizontally or vertically. A great number of problems are raised by the two systems being different among which only the ones which make the research of the region complicated are enumerated:

The vast majority of the statistical data refers to the administrative units, and to denote the borders of the centres time and settling-diagrams are needed. The contradiction can be diminished by finding factors to denote the borders of the micro-regions for which we could find data referring to the settlings, while to denote the essential analysis of the macro-regions and the ones which belong to the regions of higher level data by interpolation can be found. The present administrative distribution has not changed during the last twenty-five years, more exactly, the borders of the counties have not changed at all, only a few districts have been united. The regions of the local administration are the county and district councils. The economic development of a certain region depends to a great extent on the efficient operation of these councils. So the practical fulfilment of the development principles was altered by the administrative distribution in its own favour. From this follows that in a great number of regions of the country the subregions are represented by the county in our opinion.

— To denote the borders of the economic micro-regions, the hierarchy and the system of attractiveness of the settlings are very important factors. On the other hand it is a well-known fact that the administrative borders have a great effect on the present system of attractiveness. If it was successful to change the borders radically a completely new system of attractiveness of the settlings would be developed. E.g. the area of Dombóvár is connected with Szekszárd only as far as county functions are concerned. The abolishment of the borders of the counties would lead to the abolishment of the connections between the two towns and Dombovár would be connected with Kaposvár and Pécs, depending on which of the two became the region of the county.

— The borders of the economic units very often cut across the borders of the administrative units. This anomaly cannot exist constantly because this would lead to contradictions which could be eliminated only with difficulty.

c) From the areal distribution of the forces of labour it follows that there are only very few regions in our country which develop in accordance with their regional capabilities and according to the principle of complexity. It is a well-known fact that we can find different types of regional units in our country, such as barely developed, developed in one direction only, highly developed, or agriculturally developed, or industrially undeveloped regions, etc. The above-mentioned types are very important in respect of regional development therefore when denoting the borders of the economic regions (on each level) this fact must be taken into consideration.

d) Our country is a country of open economy, so the development of the international division of labour has a considerable effect on the development of its regions and on the tendency of the specialization. This is valid for each branch as well as each grade of centre. E.g. in agriculture the development of vegetable-, fruit-, and grape-growing can be traced mainly in the profile of the subregions (the area between the Danube and the Tisza, the county of Szabolcs, and Zala, etc.). The branches of the industrial specialization which depend on the international division of labour have their effects not only on the level of subregions but also on a higher level (aluminium works, metallurgy, certain branches of chemical industry, etc.).

In the formation of the economic regions the changes resulting from the effect of the development of the international division of labour must be taken into consideration, e.g. the valley of the Danube which is situated south of Dunaföldvár now is a developing subregions. But it will be affected to a great extent by the Main—Rhein canal as well as the hydro-electricity stations on the Danube.

e) In the historical past of the states certain parts of the country have their own peculiar development which can be traced even in their economic life. So for example, in Poland and Yugoslavia the historical fact that there were a lot of different forms of constitution has its effect even today. In this respect the territory of our country is unified but there are differences in the economic development in certain areas. Attention must be paid to the fact that in Hungary the economic regions developed together with capitalism and that their formation within the country at that time was different from the present situation, i.e. within the country after the Versailles and Paris Peace Treaties. The problems of the economic regions as well as there connections can hardly be understood without a detailed analysis of the historical past. Therefore when researching the economic units and certain production branches we must go back to the time of the development of capitalism and the above-mentioned factors must be researched in respect of the size of the country at that time. So the change of the borders of the country as well as the changes in the economic situation of the country must be analysed. The effect of the changes on certain production branches as well as on the development of the economic regions must be taken into consideration. It is especially important in the case of denoting the micro-regions which are near the border.

Besides analysing the effect of the historical past the analysis of the traditions and cultural peculiarities of certain regional units is very important, too.

During the past centuries a lot of different folk-traditional and cultural regional units have been developed in our country, such as Jászság, Nagykunság, Göcsej, Sárrét, etc. The borders of these small regional units were abolished by the economic development of the past decade. So while denoting the borders of the micro-regions we cannot take them into consideration in most cases. But on the other hand we cannot deny the fact that some of these small regional units represent micro-regions or parts of micro-regions as a result of their peculiar development (e.g. Jászság). If we do not have any other conditions we can take the folk-traditional units as economic units.

The peculiar agricultural developments developed in certain regions — especially on micro-level — must be taken into consideration while denoting the borders of economic regions. The fact that in connection with the particular development a lot of work-power of particular experience can be found in these areas cannot be neglected. To count on this work-power, to find work opportunities for these people, is also very important when denoting the development of the economic regions.

AN INDEX OF THE REGIONAL SPECIALIZATION OF INDUSTRY ON A COUNTY LEVEL

F. Móricz — Gy. Krajkó — Mrs. Abonyi

Introduction

Regional specialization is a category which denotes quantity and refers to the development level of a given economic region. Researches concerning specialization are of great interest with the introduction of an indirect control system. During the past years researches concerning this matter underwent a considerable development, the circle of the researches was extended, the methods developed and new methods — mathematical methods — were introduced.

Different characteristic features and collateral phenomena of the regional specialization were researched by Hungarian as well as foreign experts. Among the foreigners it is the Englishman John N. H. Britton, the Russians Kalashnikova T. T. and I. G. Saushkin, and among the Hungarians it is Csete L., Erdei F., and Kőszegi L. whose works are of special interest and revitalised the technical literature concerning the matter.

Specialization is a form of social division of labour by which the demands of one or more chosen branches of production come into prominence by subordinating or coordinating the others. "The branches of production which make up a considerable proportion of the production of the country and the centre as well as of foreign trade, branches which have a dominating effect in a given area and contribute to the effectiveness of the principle 'minimum labour — maximum returns' belong to the specialization of the region". With the development of the forces of production and the relations of production the specialization is extended, production as such as well as the production of goods increases, manufacturing costs go down and productivity increases. In the framework of socialism, for the sake of planned, proportional development as well as for the sake of the effectiveness of the national economy, the increase of regional specialization is necessary objectively.

Industrial specialization can be researched in different respects. One can observe structural changes concerning the whole industry, as well as the division of labour among certain units of production, certain factors, units of administration, and economic centres. The increase of horizontal and vertical division of labour follows the tendency of the development. Klaaren, Th. A., using the Heckscher—Ohlin model in researching regions in the U.S.A., came to the conclusion that "an economic region is liable to specialize in producing goods for which there is a relative abundance of the parts necessary for the production". The author made comparative and reciprocal investigations by multilateral regression-analysis. As a result of these investigations, he came to the following conclusion: "Highly industrialised regions should be specialized in those branches of industry which have production functions demanding more of the regional factors in abundance."

With this present investigation we want to know more about the regional difference of the industrial specialization connected with counties. In this work we do not want to deal with the non-utilized possibilities of division of labour, the economic success of its development, its financial, technical and material conditions, we do not want to touch the questions of the flexibility of the structurs of production. We only want to present a method of measuring the degree of specialization within the limits of Hungarian statistics.

The Method of the Investigation

In the case of a given regional unit (a county, etc.) Q_i is a quantity referring to the branch i-involved in the investigation (which can be the number of employment working in the given branch, or the value of the investment stocks belonging to the branch) and

$$Q = Q_1 + Q_2 + \dots + Q_n ,$$

where n means the number of branches involved in the investigation. It is advisable to use ratios instead of statistical data (i.e. absolute numbers). Then the P_i index referring to the proportion of branch i is given by the formula

$$P_i = \frac{Q_i}{Q} \quad (i = 1, 2, \dots, n).$$

Obviously

$$P_1 + P_2 + \dots + P_n = 1 .$$

Let $\bar{Q}$ be the *arithmetical mean* of the quantities $Q_1, Q_2, \dots, Q_n$:

$$\bar{Q} = \frac{1}{n} \sum_{i=1}^{n} Q_i = \frac{Q}{n},$$

and let σ be the *standard deviation* of these quantities:

$$\sigma = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (Q_i - \bar{Q})^2}.$$

The *relative deviation* V is defined by

$$V = \frac{\sigma}{\bar{Q}} .$$

The value of this formula is between 0 and $\sqrt{n}$ in the case of n branches.

The specialization index I of the given area is interpreted as the quotient of the relative deviation V and $\sqrt{n}$:

$$I = \frac{V}{\sqrt{n}} .$$

The specialization index can be counted up from the rations $P_1, P_2, \dots, P_n$ in a less complicated way:

$$I = \frac{V}{\sqrt{n}} = \frac{1}{\sqrt{n}\bar{Q}} \sqrt{\frac{1}{n} \sum_{i=1}^{n} (Q_i - \bar{Q})^2} = \sqrt{\frac{1}{n^2 \bar{Q}^2} \sum_{i=1}^{n} (Q_i - \bar{Q})^2} =$$

$$= \sqrt{\sum_{i=1}^{n} \left(\frac{Q_i}{Q} - \frac{1}{n} \right)^2} = \sqrt{\sum_{i=1}^{n} \left(P_i - \frac{1}{n} \right)^2},$$

as

$$Q = n\bar{Q} \quad \text{and} \quad P_i = \frac{Q_i}{Q}.$$

Taking into consideration that $\sum_{i=1}^{n} P_i = 1$ results that

$$\sum_{i=1}^{n} \left(P_i - \frac{1}{n} \right)^2 = \sum_{i=1}^{n} P_i^2 - \frac{2}{n} \sum_{i=1}^{n} P_i + \frac{1}{n} = \sum_{i=1}^{n} P_i^2 - \frac{1}{n},$$

we come to the result of

$$I = \sqrt{\sum_{i=1}^{n} P_i^2 - \frac{1}{n}}. \tag{1}$$

Now we can interpret some characteristics of the specialization index.

1. The inequality

$$0 \leqq I \leqq \sqrt{\frac{n-1}{n}}$$

is always valid. The low estimation is caused by the fact that the relative deviation V is always non-negative. The high estimation can be interpreted as follows: The specialization index I is maximal only if there is one chosen branch described of the distribution of branches in our chosen regional unit, i.e. if for a certain i $P_i = 1$, while for all the others

$$P_1 = P_2 = \ldots = P_{i-1} = P_{i+1} = \ldots = P_n = 0.$$

Then according to (1) we have

$$\mathrm{I} = \sqrt{1 - \frac{1}{n}}.$$

2. If we divide the given mezo-centre into counties, there is an obvious connection between the specialization index of the counties and those of the mezo-regions. To understand this, denote by Q_i^k the quantity referring to the branch number i in the county k, where $i = 1, 2, \ldots, n$; $k = 1, 2, \ldots, m$; m means the number of the counties. It is obvious, that

$$Q_i = Q_i^{(1)} + Q_i^{(2)} + \ldots + Q_i^{(m)} \quad (i = 1, 2, \ldots n).$$

Then

$$Q^{(k)} = Q_i^{(k)} + Q_2^{(2)} + \ldots + Q_n^{(k)} \quad (k = 1, 2 \ldots m). \tag{2}$$

On all this the contribution of branch i in the county k can be denoted by the formula

$$P_i^{(k)} = \frac{Q_i^{(k)}}{Q^{(k)}} \quad (i = 1, 2, \dots, n;\ k = 1, 2, \dots m).$$

The quantities Q_i^k, Q_i^k, Q_i^k, and Q can be seen on the following break-down:

					altogether
1. county:	$Q_1^{(1)}$	$Q_2^{(1)}$	...	$Q_n^{(1)}$	$Q^{(1)}$
2. county:	$Q_1^{(2)}$	$Q_2^{(2)}$	...	$Q_n^{(2)}$	$Q^{(2)}$
.....					
m. county:	$Q_1^{(m)}$	$Q_2^{(m)}$		$Q_n^{(m)}$	$Q^{(m)}$
mezo-region (altogether)	Q_1	Q_2		Q_n	Q

The arithmetical mean $\bar{Q}^{(k)}$, the standard deviation σ_k, and the relative deviation V_k referring to the county number k are defined by

$$\bar{Q}^{(k)} = \frac{1}{n}\sum_{i=1}^{n} Q_i^{(k)} = \frac{Q^{(k)}}{n},$$

$$\sigma_k = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Q_i^{(k)} - \bar{Q}^{(k)})^2},$$

$$V_k = \frac{\sigma_k}{\bar{Q}^{(k)}}.$$

According to the explanation the specialization index of the county number k is

$$I_k = \frac{1}{\sqrt{n}} V_k = \frac{1}{n\bar{Q}^{(k)}}\sqrt{\sum_{i=1}^{n}(Q_i^{(k)} - \bar{Q}^{(k)})^2} \quad (k = 1, 2, \dots, m).$$

According to (1)

$$n\bar{Q}I = \sqrt{\sum_{i=1}^{n}(Q_i - \bar{Q})^2}.$$

According to (2) and the obvious fact that

$$\bar{Q} = \sum_{k=1}^{m} \bar{Q}^{(k)},$$

we come to the result as follows:

$$n^2\bar{Q}^2 I^2 = \sum_{i=1}^{n}(Q_i - \bar{Q})^2 = \sum_{i=1}^{n}\left(\sum_{k=1}^{m} Q_i^{(k)} - \sum_{k=1}^{m}\bar{Q}^{(k)}\right)^2 = \sum_{i=1}^{n}\left[\sum_{k=1}^{m}(Q_i^{(k)} - \bar{Q}^{(k)})\right]^2 =$$

$$= \sum_{i=1}^{n}\left[\sum_{k=1}^{m}(Q_i^{(k)} - \bar{Q}^{(k)})^2 + 2\sum_{i\le k<j\le m}(Q_i^{(k)} - \bar{Q}^{(k)})(Q_i^{(j)} - \bar{Q}^{(j)})\right] =$$

$$= \sum_{k=1}^{m}\sum_{i=1}^{n}(Q_i^{(k)} - \bar{Q}^{(k)})^2 + 2\sum_{1\le k<j\le m}\sum_{i=1}^{n}(Q_i^{(k)} - \bar{Q}^{(k)})(Q_i^{(j)} - \bar{Q}^{(j)}).$$

The double factor can have a very simple meaning if we introduce the correlation coefficient between the data $Q_1^{(k)}, Q_2^{(k)}, \dots, Q_n^{(k)}$ of the county k and the data $Q_1^{(j)}, Q_2^{(j)}, \dots, Q_n^{(j)}$ of the county j:

$$(3)\qquad R_{kj} = \frac{\frac{1}{n}\sum_{i=1}^{n}(Q_i^{(k)}-\bar{Q}^{(k)})(Q_i^{(j)}-\bar{Q}^{(j)})}{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(Q_i^{(k)}-\bar{Q}^{(k)})^2}\sqrt{\frac{1}{n}\sum_{i=1}^{n}(Q_i^{(j)}-\bar{Q}^{(j)})^2}} = \frac{\sum_{i=1}^{n}(Q_i^{(k)}-\bar{Q}^{(k)})(Q_i^{(j)}-\bar{Q}^{(j)})}{\sqrt{\sum_{i=1}^{n}(Q_i^{(k)}-\bar{Q}^{(k)})^2\sum_{i=1}^{n}(Q_i^{(j)}-\bar{Q}^{(j)})^2}}.$$

With arrangement we gain that

$$\sum_{i=1}^{n}(Q_i^{(k)}-\bar{Q}^{(k)})(Q_i^{(j)}-\bar{Q}^{(j)}) = R_{kj}n\bar{Q}^{(k)}I_k n\bar{Q}^{(j)}I_j,$$

where we took into consideration the formula of the specialization indices I_k and I_j.

Finally we gain that

$$n^2\bar{Q}^2I^2 = \sum_{k=1}^{m} n^2(\bar{Q}^{(k)})^2I_k^2 + 2\sum_{1\le k<j\le m} n^2\bar{Q}^{(k)}\bar{Q}^{(j)}R_{kj}I_kI_j.$$

We can simplify both sides of the equity with n^2 and on multiplying with $\bar{Q}^2$ we get that

$$I^2 = \frac{1}{\bar{Q}^2}\left[\sum_{k=1}^{m}(\bar{Q}^{(k)})^2I_k^2 + 2\sum_{1\le k<j\le m}\bar{Q}^{(k)}\bar{Q}^{(j)}R_{kj}I_kI_j\right].$$

Here we can substitute $\bar{Q}$ with Q and $\bar{Q}^{(k)}$ with $Q^{(k)}$:

$$(4)\qquad I^2 = \frac{1}{Q^2}\left[\sum_{k=1}^{m}(Q^{(k)})^2I_k^2 + 2\sum_{1\le k\le j\le m}Q^{(k)}Q^{(j)}R_{kj}I_nI_j\right].$$

Here we get a weighted square mean, where the amount of the weights is:

$$\frac{1}{Q^2}\left[\sum_{k=1}^{m}(Q^{(k)})^2 + 2\sum_{1\le k<j\le m}Q^{(k)}Q^{(j)}\right] = \frac{1}{Q^2}\left[\sum_{k=1}^{m}Q^{(k)}\right]^2 = 1.$$

The formula (4) denotes the connection between the specialization index I of the mezo-region and the specialization index I_k of the counties ($k=1, 2, \dots, m$).

3. The following relation is always valid:

$$I \le \max(I_1, I_2, \dots, I_m) = I_{\max}.$$

Because on the basis of the formulas (4) and (2)

$$I^2 \le \frac{1}{Q^2}\left[\sum_{k=1}^{m}(Q^{(k)})^2I_{\max}^2 + 2\sum_{1\le k<j\le m}Q^{(k)}Q^{(j)}I_{\max}^2\right] =$$

$$= \frac{I_{\max}^2}{Q^2}\left[\sum_{k=1}^{m}(Q^{(k)})^2 + 2\sum_{1\le k<j\le m} Q^{(k)}Q^{(j)}\right] = \frac{I_{\max}^2}{Q^2}\left[\sum_{k=1}^{m} Q^{(k)}\right]^2 = I_{\max}^2,$$

where we took into consideration that the absolute value of the correlation coefficient R_{kj} cannot be greater than 1:

$$|R_{kj}| \leqq 1 \quad (k, j = 1, 2, \ldots, m).$$

But the following relation

$$I \geqq \min(I_1, I_2, \ldots, I_m)$$

is not always valid, because the counties can be on the same level in each industrial branch.

Application

To present this method, we chose the counties of Hungary. Our calculations are based upon the number of the industrial employees because on the recent level of our economy it is the industry that can be determinant as far as specialization is concerned.

Naturally — like any other branch in the field of social sciences — the whole complexity of this dynamic category cannot be presented either, having used only one arithmetical method. We approached to the problem only on the level of quantity, so the picture shown by our results is real only if we take into consideration the problems of the quality, too.

Our research was based on the following industrial branches:

Mining
Electrical industry
Metallurgy
Machinery
Vehicle-industry
Electrical engineering
Industry of communication and vacuumtechnical industry
Precision engineering
Metallurgical engineering
Building material industry
Chemical industry
Wood-working industry
Paper-industry
Printing
Textile-industry
Leather-fur-shoe-making
Tailoring industry
Home-industry
Food-industry
Other industrial branches

The index of the rate of the specialization level of the industry can be seen on the following breakdown. We formed specialization levels on the gained indexes and on the basis of all these we introduced the categories

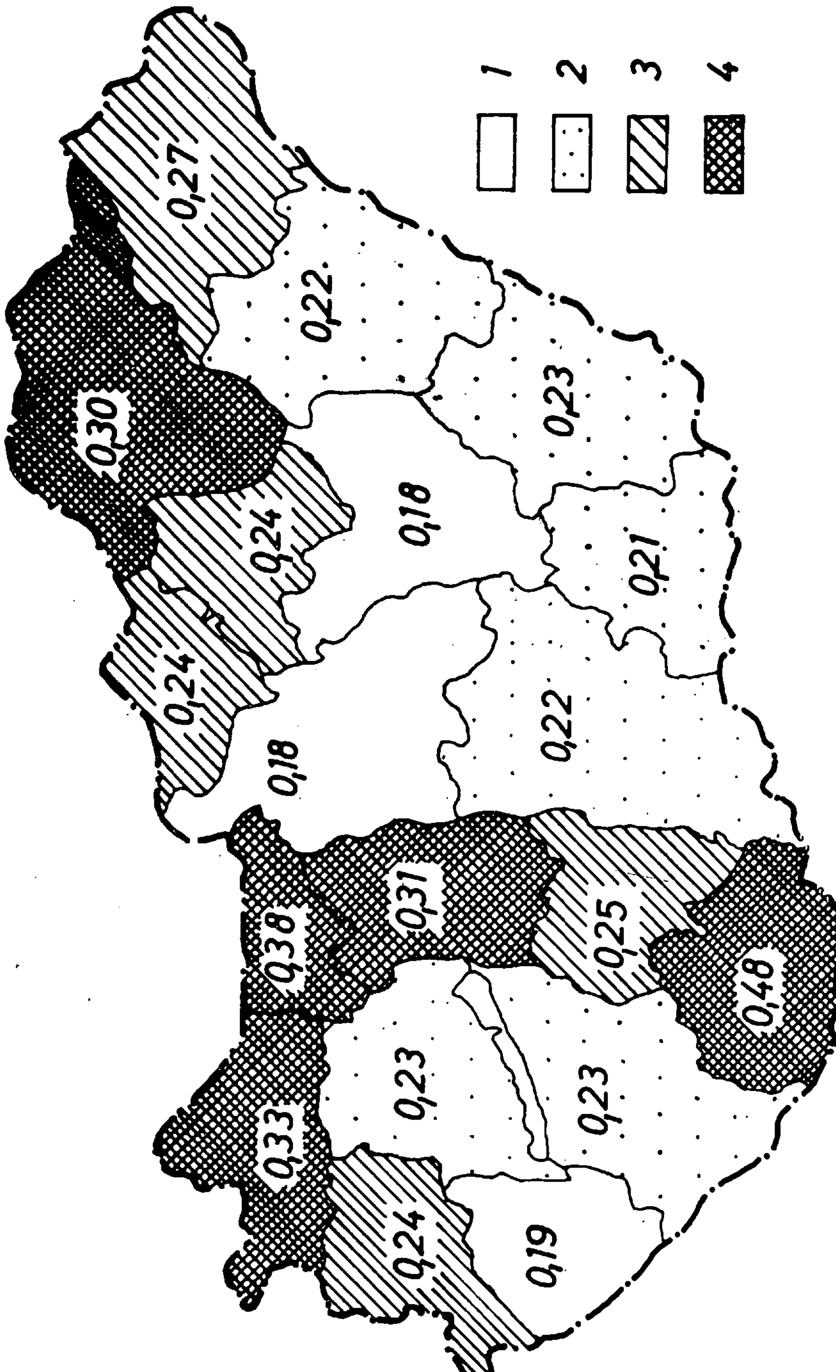

Fig. 1. Specialization of industry in our counties on the basis of the number employed in the industry (1972)
1 = hardly specialized
2 = medium specialized
3 = well specialized
4 = very well specialized

hardly specialized: $I<0{,}20$;
medium specialized: $0{,}20 \leqq I < 0{,}25$;
well specialized: $0{,}25 \leqq I < 0{,}30$;
very well specialized: $0{,}30 \leqq I$.

Looking at the diagram one can see that in the geographical division of labour the regional differences are great and that they are expressed by the productional profil of the given county. With applying our method, we gave an exact presentation of the relative specialization of the researched regional units. Further researches may come to valuable conclusions approaching to the problem in a similar way.

DEFINITION OF THE TRAFFIC-GEOGRAPHICAL SITUATION OF SETTLEMENTS OF SOUTHERN PART OF TRANS-DANUBIAN MEZOREGIONS

MRS. DÖBRÖNTE — R. MÉSZÁROS — B. CSATÁRI

To define the traffic-geographical situation of settlements is of basic importance because in this way we can see the possibilities and connections as well as characteristic features of these connections of the settlements and the economic and social life of the country.

A lot of authors have dealt with this problem in technical literature. A general characteristic feature of these researches is that they give a multilateral analysis in connection with the outstanding centres. It is of no doubt that this factor plays an important role in the life of the settlements. But attention must be paid to the fact that on the one hand the settlement function of the centres undergoes positive or negative changes because of the dynamic changes in the economic and social courses, so the modulating effect of these settlements on the traffic-geographical situation changes too. On the other hand every settlement has certain potential traffic-geographical capacities. These capacities must be taken into consideration when analysing the relationship between a settlement and a centre. These facts made us extend our analysis from a single-centred analysis to a many-centred one.

I. Characteristic features that can be used to define the traffic-georgaphical situation

1. *Road network*

a) The number of roads going through the given settlement which expresses the directions of the connection as well as the possibilities in connection with the network of roads in the country.

b) The quality of the roads which distribute the possibilities according to the real capacities of the roads given by the connections.

c) The number of bus routes which express the transport claims of the population in a given settlement (on condition that the number of bus routes is in proportion to the present claims of transport).

d) The period of time during which the place to where the population travels can be reached which restricts the possibilities given by the number and quality of the connections to the actual travels.

2. *Railway network*

The same factors were taken into consideration as in the case of the road network.

The ratio of the modulating effect within the transport-geographical situation in the case of settlements of a central role.

It is very important to measure the attractiveness of cities and city-like settlement to define the traffic-geographical situation. It is a well-known fact that there is a strong connection between the settlement network and the transport network. The hierarchy of the settlement defines the main tendencies, the number and quality of the arterial system of roads, and it is very important in the sphere of transport-attractiveness of the settlements. It is obvious that in the development of the traffic-geographical situation of certain settlements the role of cities, city-like settlements and centres of lower grade, big villages which have certain places in the hierarchy of the settlements play an important role. They have attractiveness in connection with the economic and social life. The effectiveness of this attractiveness is defined by the quality and size of their role. The distribution of the settlements which are on the same level in the hierarchy is not equal because of the areal differences of cultural, social and economic life. Their areal density is in connection with the above-mentioned factors. According to this certain settlements which have not too much of a central role or which have no central role at all can belong to more than one centre of attractiveness at the same time. This situation has an effect on their traffic-geographical situation and these basic effects must be taken into consideration throughout the research.

II. The method of defining the traffic-geographical situation of settlements

The actual definition of the traffic-geographical situation was carried our by automatic classification. The above-enumerated factors after certain modifications can be regarded as vector components, so a vector can be applied to each settlement. Then a disjunct heap of these vectors was created in an *"n"* dimension space by a computer. This disjunct heap classified the settlements into types in connection with the traffic-geographical situation and it gives a concrete indicator number too with maximum concentration (this concrete indicator number means the length of the vector applied to the central point of the disjunct heaps). So the traffic-geographical situation of the settlements can be expressed.

The main aspects in processing the most important characteristics which were used to denote the traffic-geographical situation:

1. The number and quality of the road connections if they were in close connection with one another, were not separated.

2. The same principle was followed in the case of the railway too, so the connections of the railway network, i.e. the number and quality of them were taken together.

3. During the research the unification of the index numbers of railway and road transport is an important problem.

A general principle in rayon research is that the railway transport is an element that belongs to subordinate, mezo- and macro-centres while road transport carries out connections among micro-regions. In the case of passenger transport the rail-ways can carry out connections among micro-centres too. Since in this study the passenger transport is take to be one of the basic transport factors the taxonomical distribution of the region does not differentiate between the two branches of transport. This is supported by the fact that bus transport and railway passenger transport are not in practical correlational connection. This independence of the factors proves that the elements in transport exist beside one another.

In our opinion the number and quality of the connections is only a potential possibility for the settlements so the differentiation between these two branches with regard to these factors is not needed. But the number of train-routes which similarly to the number of bus-routes expresses the transport capacities having greater transport capacities as well as the similar qualitative function of the bus and train in passenger transport can be used only with weighting.

The weighting factor can be defined by the heaped curves given by the frequency of the number of train or bus routes according to the settlements Fig.(1.)

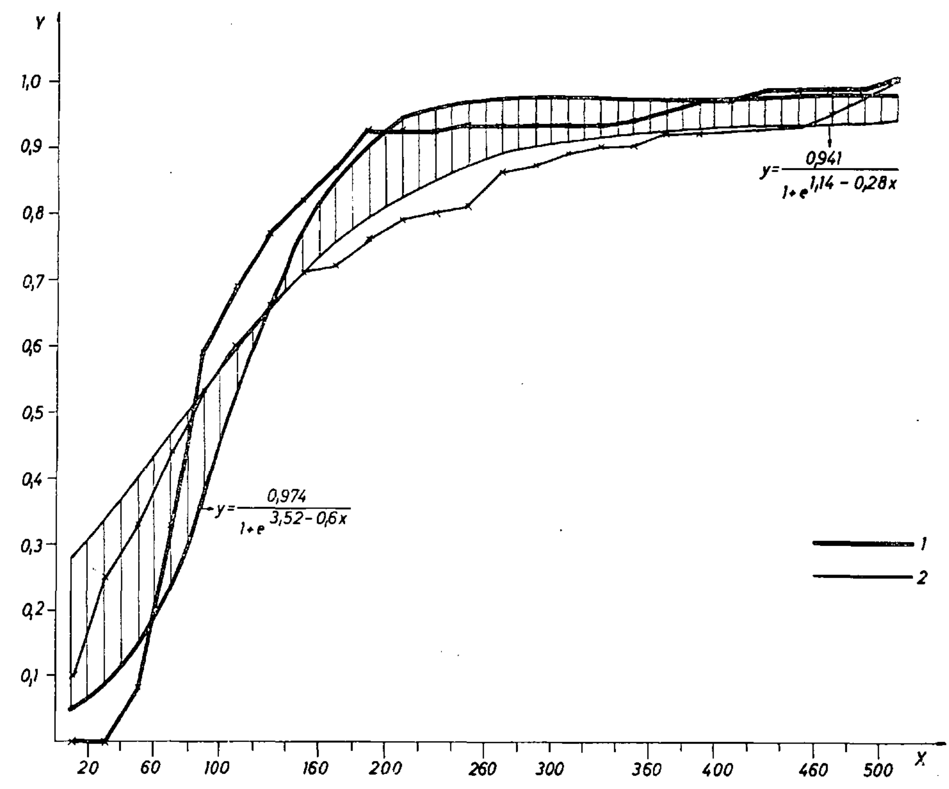

Fig. 1. The number of bus and train-routes in the mezoregion in Southern Part of Trans-danubian and the heaped frequvency values and ogives according to the routes
x = number of routes
y = relative freqvency
1 = train
2 = bus

The heaped frequency values of the number of routes can be approached sufficiently by the Pearl—Read type logistic curve.

The heaped frequency curve of the number of train routes can be denoted by the

$$y=\frac{0{,}974}{1+e^{3{,}52-0{,}6x}}$$

while the heaped frequency of the number of bus routes can be denoted by the

$$y=\frac{0{,}941}{1+e^{1{,}14-0{,}28x}}$$

logistic equation graph.

The most important characteristics:

a) The two ogives cover considerable differences. In the case of railway transport the frequency of the settlements which have 60—160 routes is extremely great while the propertion of settlement which have higher and lower numbers of routes is small. There are no considerable differences as far as the number of bus routes is concerned in the case of these settlements. It is only the proportion of the settlement which have more than 280 routes that is small, the frequency of the settlements with fewer routes is nearly the same. This is expressed by the difference between the inflection points of the two curves. (This value is $x=5.87$ in the case of the railway, in the case of buses the value is $x=4.07$.)

b) The point of intersection of the two ogives is $x=7.1$. This value is in the middle of the area marked by the graphs which means that the transport claims of the settlements are achieved.

c) The settlements which are in the area marked by the curves have close connections with the centres of attractiveness created by certain centres. In the case of the settlements which have fewer than 120 routes a week the attractive effect of the settlements which have central functions is only relative or dominant apart from certain cases while the settlings which have more than 120 routes belong to the main area of attractiveness of the centres.

d) The development of the logistic curve in our opinion proves that the qualitative function of the two branches of transport is different depending on the taxonomical level of the rayons. The road transport is first of all an element on a microregion level, so it gives only a limited possibility of creating a centre of attractiveness for the centres while with the help of the rail transport these centres can extend their centre of attractiveness, i.e. the extension of the main centre of attractiveness can be created.

e) With the development of the number of routes the relative frequency values of the settlements increase 2.15 times more quickly in the case of rail transport than in the case of the number of bus routes. Taking these facts into consideration it seems reasonable to take the weighting factor between the above-mentioned elements of road and rail transport as 2.15.

4. For the definition of the hierarchy of the settlements of a central role as well as measuring their effect of attractiveness we used the centres of attractiveness

worked out by J. Tóth. While ordering the centre settlements their central roles, functions, numbers of population as well as the quality and size of their centres of attractiveness and the population concentration according to the quality of these centres of attractiveness were taken into consideration.

We equipped some fictitious settlings with the arithmetical average of the above-mentioned data about settlements of a central role in south Trans-danubia and in relation to these data we formed nine groups of research centres:

1. Pécs
2. Kaposvár, Szekszárd
3. Mohács
4. Szigetvár
5. Bonyhád, Komló
6. Dombóvár, Tamási
7. Paks, Nagyatád
8. Simontornya, Barcs, Siklós
9. Sásd, Sellye

This was needed because of the above-mentioned fact according to which the effect of attractiveness of the centres on the settlings depends on the number of the centres as well as on their place in the hierarchy of settlements. It is very interesting that there is an extremely strong rank correlational connection between the qualitative categories, the average of the number of the population and the qualitative level ($I=0.99$).

The average values in each category of the population decrease according to the

$$y = -5556.81 + 69\,185.71 \;\cdot\; 1/x$$

hyperbolic graph parallel with the decrease in the rank which means that the quotients of the neighbouring qualitative categories form a series convergent on zero. (This counting was done for the whole territory of Trans-danubia so as to prevent the destructive effect of smaller areas.) A point system was carried out in connection with this factor in which the maximal point value given by logical counting to the settlement which is on the highest level of the hierarchy was decreased in proportion to the appropriate values of the quotient series converging on 0. (Metion must be made of the fact that the point value which was chosen for the settling which is on the highest level of the hierarchy is subjective. But since this point value decreases according to an exactly defined proportion in connection with every settling and since the action during which the student classifies the algorhythm is not destroyed or modified by the components of the vector the magnitude of the maximum point value does not change the traffic-geographical situation of the settlement, i.e. the subjective data has no distorting effect.)

To define the level of the centre of attractiveness of the centres to which the settlements which are on the lowest level of the hierarchy belong and to define the significance and the effect of the centre of attractiveness on the traffic-geographical situation of these settlements, data gained by using the above-mentioned method were used. The period of time during which these settlements can be reached was taken into consideration.

III. The traffic-geographical situation of the settlements in the mezoregion

1. *Transport conditions*

It is very characteristic of the traffic-geographical situation of south Transdanubia that considerable international roads were to be found in it during the past centuries. At present this function is accomplished by one main railway line, one main road and by the Danube. These roads of course have a very important place in the home traffic, too. The capacity of the transport network in the centre depends to a great extent on the development of the international connections of the country first of all on the connections with Yugoslavia. At the same time south Transdanubia is a part of the centralised world-wide trade which is expressed by the main directions of the areal situation of the transport network.

a) Rail transport

The length of the rail network in the centre is 1126 km which is 12.8% of the network of the country. 37.4% of this is main line, but the percentage rate of the narrow-guage lines is relatively high (5.9%). The density of the rail network (9.9 km per km^2) is sufficient and it is above the average in the country (9.5 km per km^2). There are defects in the railway network besides the relative density and these defects sometimes cause considerable transport problems: there is no railway connection between Bátaszék—Mohács and Paks—Tolnamőzs and owing to the orographical conditions rail transport is "slow" in the greater part of the centre. The main axis of rail transport is the line between Budapest—Dombóvár—Gyékényes and Budapest—Dombóvár—Pécs.

b) Road transport

12.1% of the road network in the country can be found in the mezo-region (3573 km). The length of the roads in every 1000 km^2 is 30.8 km which is hardly lower than he country-wide average (31.8 km). But the qualitative distribution of the road network does not show a favourable picture. In contrast with the county-wide 6.4% only 4.9% of the road network in the centre is first class. The percentage proportion of the secondary roads is again hardly above the country-wide average (centre: 14.7%, country: 13.9%). The values gained by analysing the quality of the road surface are below the country-wide average:

	Region %	country-wide %
concrete road	2.5	2.6
asphalt, bitumen	50.3	60.2
dust-free (excluding macadam)	52.9	65.2
earth road	4.2	3.5

Owing to the orographical conditions the width of the roads is below the country-wide average, consequently the speed of transport of goods as well as of travelling is below the country-wide average.

The main axis of the road traffic is the main road no. 6 (Budapest—Szekszárd—Pécs—Barcs) but the traffic is considerable on the roads between Pécs—Bátaszék and Pécs—Siklós, too.

c) Transport of goods

Goods transport in the two branches can hardly be compared, because both branches have their own sphere of operation and function which must be taken into consideration while comparing them. Transport on the roads is first of all the means for short-distance traffic which undertakes the goods transport within the mezo-region while the connection between regions and long-distance goods transport is carried out by the railway. But it is still worth comparing the two things because in this way functional differences can be observed. The distribution of goods characteristic of south Trans-danubia and the direction of their transport are limited and can be considered as constant according to the capacities of the area and the country-wide division of labour. The transport connections are the strongest between the capital region, Budapest, but the transport connections are considerable with Balaton, too. This can be traced by the capacity factors of the railway lines and roads in the centre (which depend on the physical state and the traffic), and according to this the lines between Budapest—Dombóvár—Gyékényes and Budapest—Dombóvár—Pécs as well as the road between Budapest—Pécs—Barcs are heavily laden. A considerable part of the roads and railway lines has free capacity but the more important crossings of the roads (Pécs, Siklós, Bátaszék, Szekszárd, Paks, Kaposvár) are over-laden. But the presence of the free capacity is indicated by the fact that the weight of the goods referring to 1 km of road and railway line isbelowfact country-wide average.

	centre (tons)	country (tons)
1 km road	3 722	5 030
1 km railway	10 479	13 931

The connection between the regions and the lowland is very weak, it is represented only by the railway line and by the road to Baja which are of a bad technical level. The connection between the centre and other areas of the country is realised by transmissions and detours on the railway which means a waste of time and there ar only secondary roads to the neighbouring regions.

The quantity of the goods transported by the railway in the centre (11.8 mt) in 1973 was 9.6% of the country-wide value. The value of road transport was greater than this (13.8 mt), but its percentage proportion of the country-wide road transport is lower than that of the railway (8.4%). So the value of the goods transported on the roads was above the value of the goods transported by rail in south Trans-danubia, too. If we take the capacity of the two branches of transport as 100% then 47.1% of it belongs to the railway (country-wide value is 42.8%). But if wel take the ton-kilometres the percentage rate of the railway is higher than that of the road (81.7%).

The areal proportions of goods transport are constant in both branches of transport. The areal distribution of the goods transport and the quality of the transport-geographical situation of the settlings are in connection with each other. The areal situation of the settlements which have favourable traffic-geographical situation are along the way of the main directions of goods transport while in the areas where the traffic-geographical capacity of the settlements is not favourable goods transport is of lower volume, too (Fig. 2 and 3).

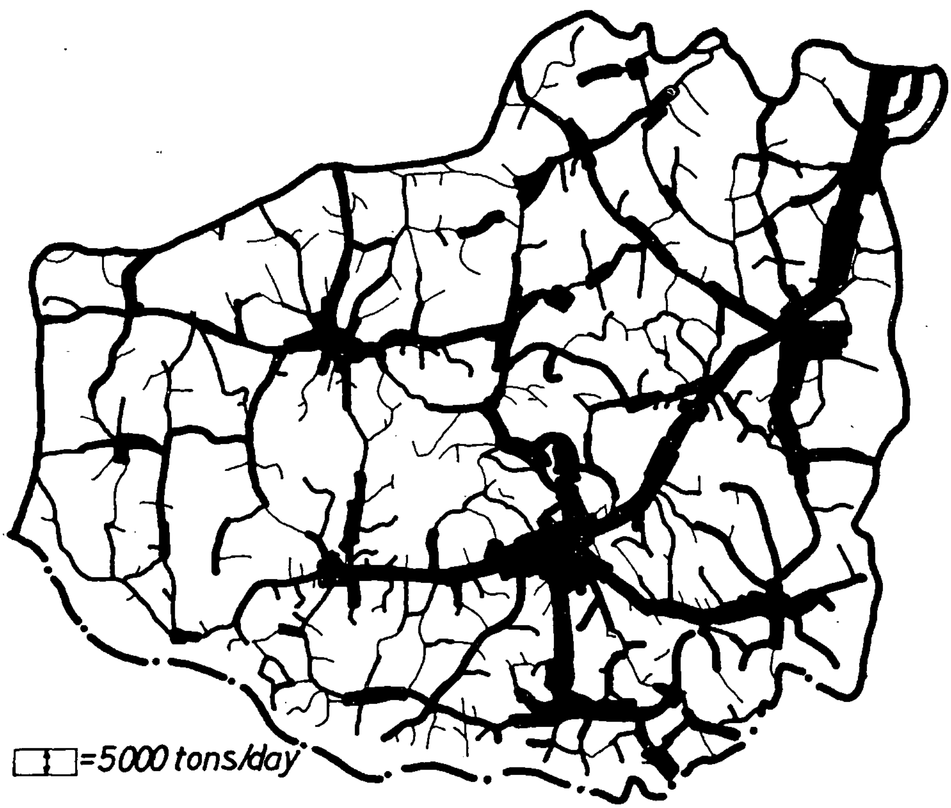

Fig. 2. The load of the roads in the south trans-danubian mezoregion (in 1970. Average daily value)

The structure of goods transport is constant, too. The on- and off-loaded goods both consist mainly of mining products. This is why the proportion of the arriving and departing products is defined by the quantity of the mining products. In spite of the fact that the majority of the goods transported on the road consists of mining products (stone, gravel, earth, sand) the products of agriculture, the food industry, and light industry are very important, too.

The areal differential of the traffic-geographical situation is reflected by the qualitative and quantitative as well as the areal distribution of goods transport.

2. *Some main characteristics of the traffic-geographical situation of the settlements:*

a) Two regional centres of the area (Pécs and Kaposvár) have very favourable

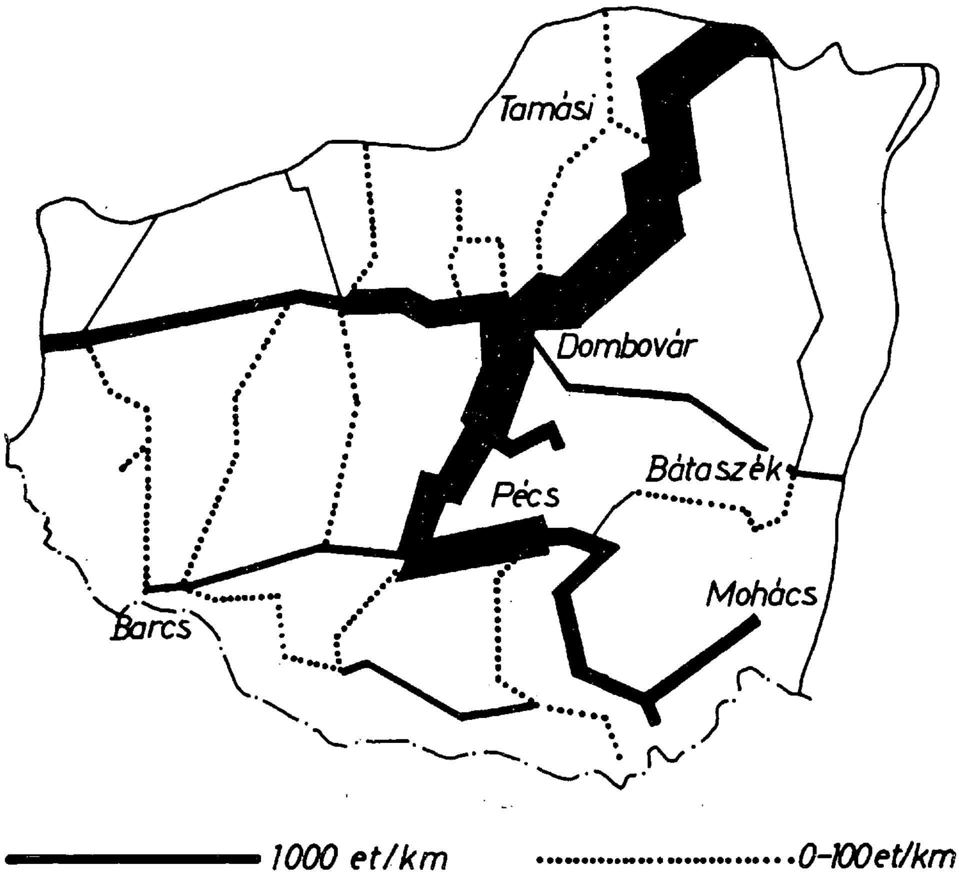

Fig. 3. Goods-transport by rail (good-tons-kilometre, 1973)

traffic-geographical situation which also indicates favourable connections between the capital and between centres of the same type in other areas. Within the centre it is the two towns that have a developing power in the traffic-geographical situation.

b) In the area of the mezo-regions there are three areas which have favourable traffic-geographical situations and which are in connection with one another:

— the bigger of these areas is the area around Pécs and in this area the proportion of the excellent traffic-geographical situation is the greatest.

— the area around Kaposvár has fewer settlements. The difference between the two areas can be explained by the fact that each town has a different regional role and the agricultural areas attached to them are different, too. But this difference can be proved by the fact that the physical geographical factors are different in each area, in this respect Kaposvár has a more favourable traffic-geographical situation. (Owing to orographical conditions Pécs is surrounded by very small villages which have unfavourable, sometimes bad traffic-geographical situations.)

— the third favourable area is around Szekszárd and Bonyhád (it has two centres) in which the centres being on different hierarchical levels have the same significance.

c) The connection among the above-mentioned three areas is one-sided because both the area around Kaposvár and the one around Szekszárd have a strong connection between the area around Pécs and there is no connection between the first two at all. The form of existence of these areas is defined by these facts, too.

d) The western part of the mezo-region has a strong connection with the area around Nagykanizsa which has favourable traffic-geographical situation, but only a few settlements are involved in this connection.

e) The settlements of outstanding central role can be characterised by the fact that they are only on the same level as the settlements around them, sometimes they are in a higher category.

f) There is a considerable amount of settlements which have a bad traffic-geographical situation. They form big areas on the southern part of the mezo-region (along the line of Nagyatád—Barcs—Sellye—Siklós) and on the northern part (along the line of Tamási—Simontornya—Paks). These areas are the most undeveloped parts of the mezo-region and in spite of the fact that there is a rail and road network in these areas the lack of an economic background destroys the traffic-geographical situation (Fig. 4.).

Summary: the density of the rail and road network in the south Trans-danubian mezo-region is favourable but in spite of this the traffic-geographical situation in the area is just around the average and it is differentiated regionally. This differentiation is not mozaic-like because there are similar and identical types of area in respect of traffic-geographical situation, too.

To choose the factors that define the traffic-geographical situation is a complicate problem. This is because of the fact that traffic-geographical situation of a certain settlement is effected by a number of different factors and on the other hand the factors of the mutual connections between the phisical, natural, social and economic conditions are very strong in the case of traffic-geograph, too.

In this present study we chose the factors which were of basic and aminent importance in the development of the traffic-geographical situation. With the help of the factors which express potential possibilities, claims and capacities, social and economic powers, the traffic-geographical situation of a certain area can be researched sufficiently and the results gained in this way are in accordance with other experiments.

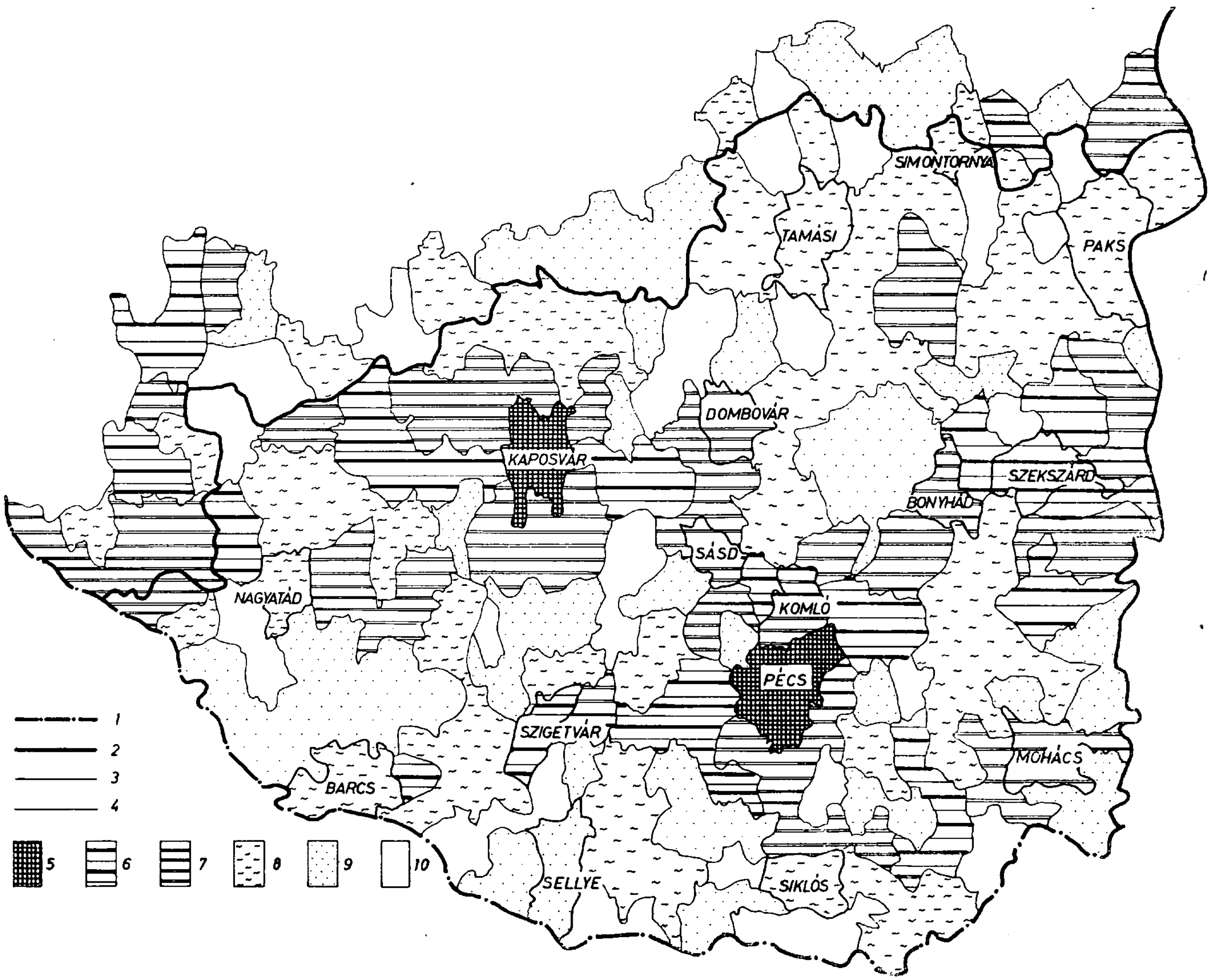

Fig. 4. Traffic-geographical situation of the settlements in the South-Transdanubian mezoregion
1 = border of the country
2 = border of the mezoregion
3 = centre
4 = type-border
5 = outstanding
6 = excellent
7 = good
8 = medium
9 = weak
10 = bad

ASSESSMENT OF THE LEVEL OF DEVELOPMENT OF THE SUBREGIONS BASED ON A FACTOR ANALYSIS MODEL PART II.

F. MÓRICZ — GY. KRAJKÓ — MRS. ABONYI

1. Economic geography deals with the laws of the areal distribution of the social forces of production. The researches can refer to the level of development of the forces of production in connection with regions of various sizes and characteristic features. These areas can be administrative units and economic regions of different level.

We chose subregions in Hungary for the analysis of the level of development in the hope of getting a real picture and real statistical data about their development. In respect of the areal distribution of the forces of labour the subregions in our country form regional production complexes. This is why the research was carried out on the level of subregions even if the data gained in this way cover certain derivations on micro-regions level.

While analysing the areas there is a need to create a complex index or complex indices which sum up and express the level of economic development of the given regional unit.

In our opinion these desired complex indices can be derived from natural indices. These natural indices can be grouped according to the main regions of the production sphere. These groups together express the development level of agriculture.

It is a very important and difficult task to choose the correct natural indices. The maximum of endeavour must be made so that there is a close relationship between the indices and the development level of agriculture.

The static indices reflecting the state of agriculture in 1972 were extended by dynamic indices. According to this the complex index expressing the development level contains the constant tendency of the past few years.

In the following we are going to deal with the indices which in our opinion denote the development level of agriculture.

2. The development level of agriculture is expressed by the indices indicating the material technical equipment. In the statistical practice these indices refer mainly to regional units and rarely to the employment within agriculture. If the analysis of the level of development is done on macro-level it is the number of the population that makes the basis. The material technical level of agriculture is indicated by the tractor equipment (which is measured by a regional unit cultivated by a tractor), power machine equipment (pulling-power is expressed in tractor units per 100 hectare unit), and the degree of mechanisation of the various agricultural operations which is denoted by the proportion of the manual work and the mechanised operation.

The development of agriculture is denoted by the grade of intensification, too. The degree of intensive stock-farming can be expressed by the proportion of irrigated area, the size of the area involved in fertilisation, the quantity of chemical fertiliser used in an areal unit, the extension of application of up-to-date weed-killers and by the areal proportion of gardens, orchards and vineyards.

The standard of agriculture in connection with arable farming can be expressed by the average crop. Mention must be made of the fact that in agricultural production the quality of the soil has an important role even today beside the material technical equipment. This value of the soil is expressed by the "golden crown value" of the soil.

These days the proportion of the arable and stock agriculture is favourable. The results of the closed cycle, industry-like pig-breeding are very good, which contributes to the development of the meat resources of the country as well as the meat production. A great development took place in cattlebreeding, too, during the past few years (for beef cattle as well as dairy cattle). To denote the standard we can make indices of the total number of livestock in connection with a given regional unit, a certain number of the population, an agricultural area, as well as the quantity of provender needed to produce one kilogram of meat, the average milk production, etc.

Indices used to denote the level of development of agriculture are as follows:

1. The percentage rate of active employment in forestry, agriculture and the management of water supplies.
2. The percentage proportion of the total arable land of the country represented by the arable land of the subregions.
3. The percentage proportion of the area covered by gardens, orchards and vineyards within the total area of land of the subregions.
4. The financial outlay on forestry, agriculture and the management of water supplies per head of the population (in forints).
5. The investment on one hectare of arable land (in Ft.).
6. The amount of the chemical fertiliser supply for one hectare (in kilograms).
7. Tractor supply on 100-hectare units.
8. The number of lorries on 100-hectare units in agriculture.
9. The percentage rate of the tractor supply in 1972 in comparison with that in 1962.
10. The percentage rate of the irrigated area with regard to the total area of the country.
11. The livestock (cattle, pigs, horses and sheep) on agricultural areas of 100 hectares on the basis of the census taken in the spring of 1973.
12. The trade of meat animals and products of animal origin with regard to the total trade.
13. The assets of the agricultural cooperatives in respect of one 100-hectare area (in Ft.).
14. The total income of a member of an agricultural cooperative (in Ft.).
15. Milk trade on one hectare of land (in liters).
16. The average crop of wheat from one hectare of land (in q).
17. The average crop of rye from one hectare of land (in q).

TABLE 1

Areal differences of the development level in the agriculture

1. indicator	1,000																
2. indicator	0,037	1,000															
3. indicator	0,384	0,153	1,000														
4. indicator	0,427	0,062	−0,002	1,000													
5. indicator	−0,226	−0,118	−0,185	0,612	1,000												
6. indicator	−0,211	−0,113	0,068	0,287	0,373	1,000											
7. indicator	−0,248	−0,479	0,211	−0,078	0,023	0,504	1,000										
8. indicator	−0,573	−0,138	0,115	0,146	0,693	0,466	0,340	1,000									
9. indicator	0,172	−0,179	−0,068	−0,386	−0,475	−0,277	−0,236	−0,520	1,000								
10. indicator	0,205	0,059	−0,421	0,300	0,183	−0,383	−0,318	−0,230	−0,041	1,000							
11. indicator	0,026	−0,319	−0,135	−0,537	−0,489	0,117	0,207	−0,487	0,656	−0.202	1,000						
12. indicator	−0,338	−0,262	−0,481	−0,396	−0,306	0,332	0,349	−0,165	0,321	−0,233	0,650	1,000					
13. indicator	—0,157	−0,255	−0,021	0,218	0,665	0,372	0,088	0,651	−0,105	0,157	−0,121	−0,073	1,000				
14. indicator	−0,287	0,037	−0,453	0,405	0,623	0,330	−0,088	0,479	−0,297	0,533	−0,288	−0,012	0,675	1,000			
15. indicator	−0,342	−0,285	−0,219	−0,453	−0,333	0,331	0,354	−0,101	0,584	−0,374	0,768	0,727	0,023	−0,024	1,000		
16. indicator	0,115	−0,002	−0,214	0,649	0,695	0,249	−0,329	0,240	−0,241	0,510	−0,293	−0,340	0,475	0,689	−0,367	1,000	
17. indicator	−0,313	0,077	−0,043	−0,404	−0,083	−0,103	−0,034	0,232	−0,282	0,063	0,000	−0,131	0,106	0,258	−0,085	−0,126	1,000

3. In the following we used the method of factor analysis to research the development level of agriculture in the subregions and on the basis of the factor model gained in this way we graded the subregions and grouped them according to the development level of agriculture.

The programme of counting was done by the computer CDC—3300 in the research department for counting and automatisation of the Hungarian Academy of Sciences.

The correlation matrix of the 17 indices in paragraph 2 can be seen in table 1. As can be seen in the table the correlation of the even numbers shows very loose connections in the case of 85% of the indices (the value of the correlation co-efficient is below 0.50), while in the case of the remaining 15% the strength of the connection is medium, the correlation co-efficient is between 0.51 and 0.79. The researched indices show a system in which there is no strong mutual dependence among the majority of the indices. This fact refers to the peculiar characteristic of agriculture that shows that the development level is denoted by a vast number of indices which are in loose connection with one another. The temporal development of the indices is partly independent, too.

In spite of this the factor analytical model can be applied to agriculture according to our researches. We took seven factors into consideration which refer to more than 90% of the dissipation squares. In the case of the eighth and further factors the denotation referring to the variants is below 5% and so can be interpreted as a chance effect.

The number of the factors as the total result and the dissipation squares denoted by each factor with reference to the percentage rate of the dissipation squares of the total number of factors, see table 2.

TABLE 2

The order of factors	The contribution of the factors to the dissipation squares of the variables	The dissipation square denoted by the factors in % relationship with the dissipation square of all the variables	
		Dispersion of factors	Cumulative dispersion
1.	4,974	29,3	29,3
2.	3,474	20,4	49,7
3.	2,340	13,8	63,5
4.	1,876	11,0	74,5
5.	1,128	6,6	81,1
6.	1,002	5,9	87,0
7.	0,849	5,0	92,0

While the first factor denotes 30% of the total dissipation squares further factors denote 60%. So the role of the first factor is not dominant in comparison with the other factors, i.e. the mutual dependence among the researched indices is not strong so they can be characterised by an inbalance rather than by complexity. This inbalance is not only considerable but also multilateral.

The connections between the researched, original indices and the factors are expressed by the factor-weights (see Table 3). The factors that have strong factor-

TABLE 3

indicators \ factors	K_1	K_2	K_3	K_4	K_5	K_6	K_7
1.	−0,035	*−0,666*	0,056	*−0,573*	0,228	−0,004	0,325
2.	0,119	−0,454	−0,120	0,344	−0,455	*0,575*	0,189
3.	−0,058	−0,265	*−0,757*	−0,278	0,364	0,271	0,137
4.	*0,718*	−0,204	0,070	*−0,535*	−0,223	−0,066	0,121
5.	*0,862*	0,302	0,040	−0,131	0,004	−0,004	−0,234
6.	0,230	*0,685*	−0,195	−0,415	−0,270	0,248	0,295
7.	−0,146	*0,623*	−0,435	−0,242	0,029	−0,437	0,248
8.	*0,610*	0,586	−0,412	0,169	0,116	0,067	−0,227
9.	*−0,646*	−0,055	0,466	*−0,223*	0,299	0,303	−0,271
10.	0,407	−0,330	*0,658*	0,165	0,135	−0,291	0,215
11.	*−0,748*	0,324	0,344	−0,200	0,171	0,113	0,201
12.	*−0,545*	*0,602*	0,323	−0,078	−0,353	−0,071	0,040
13.	*0,572*	0,495	0,144	−0,096	0,474	0,236	−0,072
14.	*0,711*	0,381	0,458	0,185	0,009	0,123	0,212
15.	*−0,615*	*0,646*	0,233	−0,067	0,022	0,225	0,079
16.	*0,774*	−0,021	0,420	−0,221	0,043	0,142	0,066
17.	0,037	0,183	−0,111	*0,755*	0,332	0,005	0,445

weight connections with a certain factor are illustrative especially of each researched factor, because this means that the dissipation of the given original index is denoted by this given factor.

There is a strong connection between one variable and the first factor (the value of the factor-weight is at least 0.800): This is the investment in one hectare of arable land (5). The next nine variables have medium-strength connections with the first factor (the value of the factor-weight is between 0.501 and 0.799): this is the investment on one head of the population in forestry, agriculture and the management of water supplies (4), the number of lorries for each 100 hectares of arable land in agriculture (8), the number of tractors in 1972 in percentage relationship to those in 1962 (9), livestock on every 100 hectare area of farm-land (11), the trade in meat animals and animal products in a percentage relationship with the total trade (12), the total assets of the agricultural cooperative on one hectare of arable land (13), the average income of a worker in an agricultural cooperative (per annum) (14), cow-milk trade on one hectare of farm-land (15), and the average crop of wheat from one hectare of arable land (16).

Five variables have medium-strength connections with the second factor; employment in forestry, agriculture and management of water supplies in a percentage relationship with the whole active employment (1), chemical fertiliser supply for one hectare of arable land (6), the number of tractor units on 100 hectares of arable land (7), the trade in meat animals and animal products in a percentage relationship with the total trade (12), and cow-milk trade on one hectare of farm-land (15).

Two variables have medium-strength connections with the third factor: the area of vineyard, orchard and garden in a percentage relationship with the total area of the subregions (3), the irrigated areas in a percentage relationship with the total farming area (10).

Three variables have medium-strength connections with the fourth factor: the employment in forestry, agriculture and management of water supplies in a percentage relationship with the total active employment (1), the accomplished investment on one head of the population in forestry, agriculture and management of water supplies (4), and the average crop of rye from one hectare of arable land (17).

One variable has medium-strength connection with the sixth factor: the farming area of the subregions in a percentage relationship with the total farming area of the whole country (2). There is no medium-strength or stronger connection between variables and the fifth and seventh factors.

According to the above-mentioned facts at present the development level of agriculture in the subregions is defined by the first two factors which express the intensity of the agriculture, but the factors which express the size of gardens, orchards and vineyards, the size of the irrigated areas (factor 3); the fourth factor representing forestry, agriculture and management of water supplies; the sixth factor which expresses the size of the farming-land area within the subregion all these factors are of some importance. To sum up we can say that the development level of agriculture on subregions level is defined by the following factors:

a) the intensity of the agriculture,
b) the size of the vineyards, orchards and gardens,
c) the size of the irrigated areas,
d) the role of forestry, agriculture and management of water supply,
e) the area of the arable land within the subregions.

The first of these is the most important, the significance of the other four is the same.

On the basis of the factor-analytical model we counted down the correlation co-efficients among each variable and we gained and reproduced a correlation matrix in this way. By comparing the original correlation matrix and the counted-up, reproduced correlation matrix we can see the reality of the factor-analytical model. The difference of the order of magnitude between the elements of these two matrices can be seen in table 4. As can be seen in table 4, the matched correlations of the factors are reproduced sufficiently by the analytical factors. This proves that the factor-analytical model can be used in analysing the development of agriculture.

TABLE 4

Order of magnitude of the derivation	Distribution in % of all the matcaed correlation
0,010	22,1
0,011—0,050	66,1
0,051—0,100	11,8
0,101	0,0

Then we defined the value of the first three factors in each subregion and on the basis of this we made a list of the subregions according to their development level. The factor values K_1, K_2 and K_3 mean three orders which were united with the help of a weighed, mathematical average. (According to the part proportion K_1 was weighted 29.3, K_2 20.4, and K_3 13.8.) The results are summed up in Table 5.

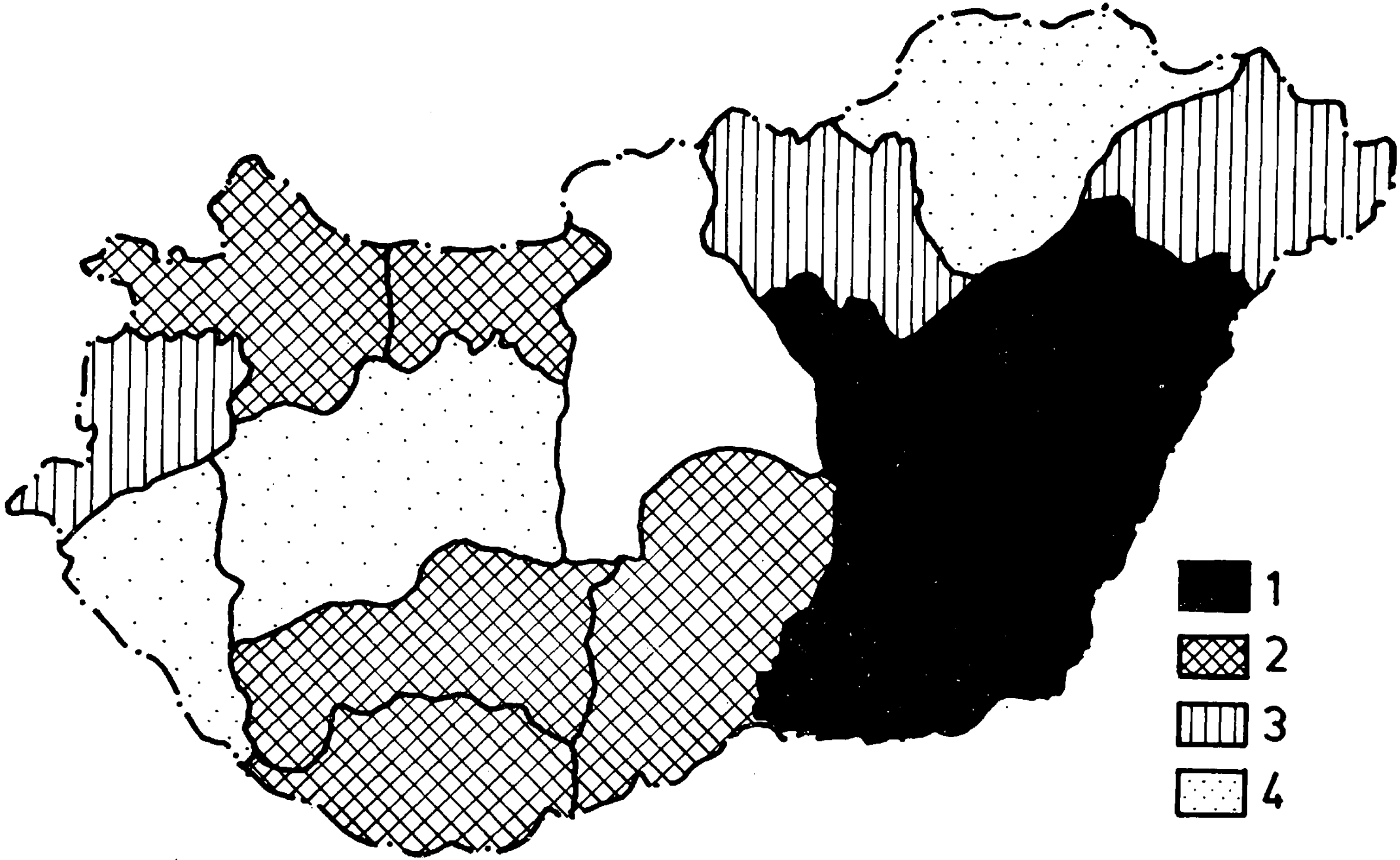

Fig. 1. The territorial differences of development of agricultural
1 = highly developed
2 = developed
3 = medium developed
4 = under-developed

TABLE 5

Subregion	The value of K_1	The value of K_2	The value of K_3	The order of agricultural development level
Csongrád	0,112	0,096	0,576	3
area between Danube-Tisza	−0,262	0,276	0,237	5
Békés	0,024	0,235	0,565	4
Szolnok	0,876	−0,109	0,521	2
Hajdú	0,330	0,079	0,402	1
Szabolcs	−0,837	0,343	−0,037	11
Borsod	−0,297	−0,139	−1,013	15
Nógrád	1,583	−0,740	−0,654	10
Győr	0,045	−0,097	0,138	9
Szombathely	−0,846	0,300	0,208	12
Zala	−2,876	0,931	−0,528	13
Komárom	2,111	−1,115	−0,051	7
Baranya	0,143	−0,043	0,054	6
Tolna	0,265	−0,118	−0,049	8
Veszprém	−0,370	0,101	−0,370	14

On the basis of this we grouped the subregions according to their development level. By creating four grades we came to the following result:

Hajdú Szolnok Csongrád Békés	highly developed
the area between Danube and Tisza Baranya Komárom Tolna Győr	developed
Nógrád Szabolcs Szombathely	medium developed
Zala Veszprém Borsod	under-developed

4. Mention must be made of the fact that the criterion combinations created by the factor analysis can refer only to concrete research units and periods of time. So the researched criteria cannot be generalised theoretically into sufficient factors. In spite of this we think that the factors which express the development of agriculture in the subregions as well as the order of development of the subregions made by the factor-analytical model agree to a great extent expert opinion.

THE INDUSTRIAL DEVELOPMENT LEVEL OF THE NORTH-HUNGARIAN MACROREGION

MRS. DÖBRÖNTE

The most important element in the economic structure is industrial production which always defines the economic life of a given area. It is obvious that the economic activities which are sometimes in mutual connection with one another or they can be independent define the development level of the economy in a certain area but the industry which is predominant in this correlation is the most important in the characterisation at this level.

By defining the development level of industry we can research the industrial production of the rayons ànd this gives us the spossibility to analyse the industrial potential of the centres which are expressed through different levels and structural distribution. This also can be used to denote the tendency and the intensity of the development.

The method of the development of industrial production

The task can be summed up as follows:

An n number of economic regions is given and its industrial development level is represented by an m number of identical economic factors.

To denote the development level since it is relative a relative base is needed which in this case is provided by a fictitious economic unit which is equipped with the arithmetical average of the appropriate data of the regio number n. The creation of this fictitious regio is caused by the fact that characteristic criteria in the researched centres have considerably great dissipation depending on the centralisation or decentralisation of the industry. Since the data about the fictitious region are derived from original values so they are not independent of them, these are arithmetical averages, their dissipation is around the average, so they can be suitable relative bases for the practical counting.

A further essential element of the method is to make the data homogeneous which can be done in two phases.

1. Distorting effects in the size and population number of the researched regions must be avoided which can be done by carrying out the counting for one head of the population.

2. The relation to the appropriate data about the fictitious regions makes it unnecessary to use measurements.

After making these changes the necessary data are gathered to form a factor representing the development level from which the desired factor can be gained by doing "selfvalue" counting.

Mention must be made of the fact that the usage of this factor can result in distorted pictures sometimes. Viz., some outstandingly great value of one or two economic factors can result in bigger values in the united factor in spite of the double relation. It is obvious that one or more bigger investment in one or two settlings cannot change the industrial tendencies of the environment because it does not result in the development of further factors. This fact refers to another essential fact: to the areal situation of the industry which must be reflected by the level of development.

To measure the areal situation of the industry we can use a certain *"industry-density"* factor.

Since the areal situation of the industry can be located exactly, to define the factor the settlings can be used as the smallest units.

The centralisation of the industry must be expressed in the *"industry-density"* factor (the proportion of settlings with industry), the industrial employment of the whole centre (the proportion of the industrial employment in the whole population of the centre), the employment degree of the industrial settlings (the proportion of the industrial employment in relation to the whole population of the industrial centre).

In the series of these factors the proportions improve one another and the areal distribution of the industry, the degree and proportion of the employment, is reflected by the size of the series. Since this factor has no measurement, it is only a relative number, its characteristics make it possible to modify the factor which refers to the counted development level. (The correctness of the modulation was proved in practice.)

The above-mentioned method describes the development level of the industry in an economic unit, the areal distribution of the industry as well as the weight of certain economic characteristics. Useful experience can be gained during the description of a centre in a given period of time (during a year). To evaluate the industrial production of an economic centre in its change and development attention must be payed to the qualitative and quantitative changes which take place during a certain period of time as well as to structural changes and their intensity. To carry out an analysis of this type the method which describes the dynamic development of the industry can be employed.

This method uses the development level to define the development dynamism. In a given period of time it is the development level that contains the most important employment and technical factors of the industrial branches. On the other hand it gives the relative weight of an economic unit in an economic region which belongs to a higher level. So the development dynamism can be expressed by the changes between the development level and proportion.

The quantitative changes of the most important economic factors and the changing of the population are expressed in the changing of the development level while the changes of the relative weight of the given economic centre is expressed in the change of the development proportion.

Since this present study presents the analysis of a dynamically developing regio of the people's economy, i.e. the industry, the tendency of the absolute changing is increasing while according to the different degrees of industrialisation the relative weight of the economic units is varying. So the synthesis of these two components which can be sometimes of different tendencies can be done by *"selfvalue"* countin in each micro-regions.

Percentage distribution and change of characteristic indicators according to microregions

	Population			Profession			Place of work			Applied electric power			Fuel			Constant goods		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
1.	4,8	5,3	13,1	9,2	7,4	5,8	9,9	8,4	23,0	13,5	13,6	56,1	17,8	14,3	16,3	12,8	9,0	5,7
2.	1,1	1,1	5,1	2,7	2,2	6,1	2,7	1,5	−20,3	3,4	2,7	25,5	5,3	3,5	−5,5	4,1	2,4	—2,6
3.	2,0	1,8	−4,1	1,6	1,3	8,4	1,6	1,4	29,0	0,7	0,6	23,9	0,9	0,8	26,1	1,3	0,9	20,1
4.	2,0	2,0	3,0	3,2	2,6	6,9	2,3	2,2	39,4	4,1	2,9	7,2	2,7	1,5	−20,0	2,3	1,7	22,1
5.	1,1	1,1	3,9	0,8	1,1	73,3	0,5	0,6	94,8	4,5	8,9	207,7	3,2	3,8	68,2	2,7	3,5	118,8
6.	1,7	1,7	1,5	2,1	2,5	55,9	2,7	2,9	52,3	1,6	2,3	126,0	3,1	6,0	174,2	2,4	5,6	289,7
7.	2,5	2,4	−1,4	2,0	2,2	43,8	2,4	2,3	38,7	1,3	1,3	50,2	1,4	1,5	49,0	1,8	1,7	57,3
Macroregoin	15,2	15,4	4,6	24,6	19,3	17,2	22,0	19,3	26,8	29,1	32,3	71,7	34,4	31,2	31,0	27,4	25,0	50,3
Country without Budapest	100,0	100,0	2,7	100,0	100,1	31,3	100,0	100,0	44,7	100,0	100,0	55,1	100,0	100,0	44,0	100,0	100,0	64,9

1 = Microregion Miskolc 2 = Microregion Ózd 3 = Microregion Sátoraljaújhely a = 1965
4 = Microregion Salgótarján 5 = Microregion Leninváros 6 = Microregion b = 1972
Gyöngyös 7 = Microregion Eger c = 1972/65

The application of this method in the microregions of northern Hungary

Because of its rich natural resources the macro-region in northern Hungary became one of the most considerable industrial regions of the country. The development of the industry was defined by the heavy industry which was planted on the considerable coal-mining, and on the mining of different ores. Today coal-mining has lost its industry-forming power and together with the modernisation of the energy structure of the country its significance is decreasing. This does not modify or put an end to the industrial development and tendency of the macro-regions, but it leads to changes in the structure of the distribution of industrial branches which is the main tendency of our time.

The data in Table 1 prove the industrial tendency and the highly developed industrialisation of the region. The area of the regio occupies 14% of the country with 15.5% of the population. (The country-wide data exclude the data about Budapest.) The factor characterising the industry are above the values of the principle of proportional distribution. This is especially striking in the case of the technical factors of which the distribution of the macro-regions is 1×4—1×3. Naturally the micro-region distribution describes essential differences.

The development between 1965 and 1972 is below the country-wide proportion on macro-region level. This is in harmony with the tendency which tries to distribute industry as well as helping to develop it on certain undeveloped parts of the country. Naturally the industrial traditions, the highly developed branches, the favourable possibilities for cooperation, the given and extendable infra-structural network as well as many other favourable conditions, make it possible to develop the industry so this region will be the representative of the considerable part of the industrial potential of the country in the future.

Areal distribution of industry

Agglomerations of considerable size developed in the area which define the areal distribution of the industry. The biggest industrial agglomeration is the Borsod concentration which starts in Ózd micro-region and comes along to Miskolc micro-region and extends as far as Leninváros micro-region. In the western part of the macro-region the Nógrád—Heves industrial agglomeration can be found which is in the area of Salgótarján and Gyöngyös micro-regions. There is a new industrial concentration around Gyöngyös and Eger which is independent of the above-mentioned concentrations and which has a concentration of a lower level. For the other areas of the macro-region localised grouped industrial centres can be found but there are considerable industrial undeveloped areas too.

On the basis of these industrial grougings it is understandable that there are big differences among the areal distributions of the micro-regions as well as within the micro-regions.

Ózd micro-region has the most favourable industrial density because its whole area is in connection with the Borsod concentration. Similarly to this the Salgótarján and Gyöngyös micro-regions are above the average as far as the industrial density is concerned, but the level of employment in them is lower than that in Ózd.

Miskolc micro-region has a special situation. Although the greatest part of the Borsod concentration can be found in this micro-centre its industrial density is hardly above the macro-region average. This is caused by the fact that the highly developed industrial area is concentrated in the wider Sajó valley and there is a sharp border between the other areas of the centre. There is a big area with a large population in front of it, on its northern part which is industrially undeveloped and in which the industry is located and is of small volume. There is hardly any industry in the area which is south of it.

The Eger, Leninváros and Sátoraljaújhely micro-regions have low industrial density. The developing industrial concentration around Eger cannot counterbalanc the undevelopment of industry in Eger micro-region. The situation is similar in Leninváros micro-region where, although the northern part of the area belongs to the Borsod concentration, at present it is only the industry of the centre which is outstanding.

Sátoraljaújhely micro-region has the most unfavourable industrial density. Only three bigger settlings have industry there.

Changes in areal distribution of industry between 1965 and 1972:

1. The degree of decentralisation is decreasing in the micro-regions so the employment level was dominant in the modulation of the industrial density.

2. The factor of industrial density increased in the micro-regions which were excluded from the traditional industrial agglomerations (Eger, Gyöngyös, Leninváros and Sátoraljaújhely micro-regions).

3. The fact that the highly developed and the undeveloped micro-centres got closer to one another, i.e. that the difference of industrial density decreased to a degree of 5.87 from 9.75 (in 1965) shows the industrial development of the micro-regions. Mention must be made of the fact that this tendency hardly touched the industrially undeveloped areas, these data refer to the developing industrial agglomerations, so the differences within the micro-regions became even bigger.

The order of development of microregions

The first principal problem of the analysis of the industrial development level is the right choice of the appropriate economic factors. The factors are supposed to represent the industry in the research centres as well as describing the real differences in their real proportions among the areal units. Besides this some practical rationalities and effects of statistical data must be taken into consideration.

Taking into consideration the above-mentioned problems the following economic factors can be used to describe the industrial development level:

1. Employment factors:
   a) The number of industrial employment,
   b) the number of workshops.
2. Technical factors:
   a) the electrical power consumed (1000 kw),
   b) the capacity of electric motors used for the operation of power machines (kw),
   c) the gross value of investment stocks (1000 Ft).
3. Development factor:
   a) the value of investments in 5-year periods (1000 Ft).

4. The factor of the areal distribution of industry:
   a) industry density factor (relative number).

Taking into consideration the above-mentioned factors the orders of micro-regions in northern Hungary are as follows:

1965

Order	Microregions	Development level	Development proportion
1.	Ózd	0,112	3,87 very well
2.	Miskolc	0,097	3,35 developed
3.	Salgótarján	0,041	1,41 developed
4.	Leninváros	0,013	0,45
5.	Gyöngyös	0,010	0,35 un-
6.	Sátoraljaújhely	0,0029	0,10 developed
7.	Eger	0,0028	0,098
	Fictitious	0,029	1,00

1972

Order	Microregions	Development level	Development proportion
1.	Gyöngyös	0,187	4,68 very well
2.	Ózd	0,094	2,35 developed
3.	Miskolc	0,050	1,25 developed
4.	Leninváros	0,041	1,03 medium
5.	Salgótarján	0,035	0,88 developed
6.	Eger	0,015	0,38 un-
7.	Sátoraljaújhely	0,005	0,13 developed
	Fictitious	0,040	1,00

The industrial development level of the micro-regions shows extremely big differences.

Ózd and Gyöngyös micro-regions belong to the highly developed category (the difference between them is 2.0:1). Ózd micro-region was one of the most highly-developed micro-regions on the bais of its development level but it showed a decreasing tendency during the researched period of time. The change is caused by the alteration of the industrial structure in the micro-region. The centre was outstanding on the basis of the production of its resource industry, the role of which was still dominant during the period of the research but the branches of light industry and food production show increasing tendencies which will lead to changes in the one-sidedness of the micro-regions.

Gyöngyös micro-region became one of the leading industrial centres of northern Hungary by 1972. While in 1965 with its undeveloped industry it belonged to the undeveloped category its industrial level became 18.7 times higher during the researched period. This dynamic development is only partly the consequence of its electric energy production and the attached coal-mining because the level of the manufacturing industrial branches became very high, too. (Outstanding branches are the machine industry, the textile industry, and the canning industry.) So the micro-centre can be characterised by a developed industrial structure and further development of the two industrial agglomerations in the area of the centre is expected.

Miskolc micro-region is highly developed industrially although there is a considerable difference between this micro-centre and the above-mentioned ones. During the researched period its industrial development factor decreased to one half of the original and its relative weight became 2.7 times smaller. Although there was a considerable increase in the values of the industrial factors, this increase was too small to counterbalance the different effect of the increase of population as well as the effect of the positive change in the macro-centre average.

The change in the structure of industry had an important role in the decrease of the development level besides the above-mentioned facts. The heavy industry especially the resource industry specialisations in the micro-region, but also the branches of manufacturing industry, are highly developed. During the researched period there was a considerable decrease in the resource industry in contrast with the dynamic development of the manufacturing industry. This change is the continuation of the process which started to change the structure and this can be considered as the expectable tendency of the further development.

Leninváros and Salgótarján are medium-developed industrially (in a country-wide research both can be considered as highly developed centres), but their tendency of development and dynamism are different.

The relatively small industrial development of Salgótarján micro-region could not counterbalance the dynamic development of other micro-regions, therefore there is a tendency in its relative and absolute values. This fact was caused by the reduction of coal-mining. The reconcentration of the employment made it necessary to create new work-opportunities which demanded the development of new industrial branches at the same time. This naturally led to the modulation of the industrial structure as well as to extensive development according to the problem. After initial differences the industrial development will become dynamic and extensive which will lead to the shifting of the industrial structure towards manufacturing branches.

Leninváros micro-region in contrast with the above-mentioned one is a dynamically developing economic unit. (It increased its level of development besides developing the average to an extent which is 3.7 times more than the original.) At present it is in the state of development. It is true that the central part of the industry was created as an organic unit of the Borsod concentration, but it started to develop on its own towards the end of the 60's and it formed a new micro-region separating from Miskolc micro-region. This is why at present it is only a one-sided resource industrial centre and according to the social economic conditions the development was strongest in these branches between 1965 and 1972. Among the branches of its manufacturing industry only the significance of the machine industry became stronger.

Eger and Sátoraljaújhely micro-regions are industrially undeveloped economic units. The stronger and many-sided development of Eger micro-region is three times stronger than that of Sátoraljaújhely. Among the industrial branches it is the machine industry that represents a higher level and further industrial specialisation concerning this branch is expectable. There is no such kind of division of labour in Sátoraljaújhely micro-region. Although its sweet industry has a leading role within the micro-centre it can still be considered as an industrially undeveloped micro-region because of the low level of its total industry.

A dynamic industrial development took place in the micro-centre in the researched period. As a result of this changes took place in the order of the micro-regions which is due to the different development dynamism.

Using the changes of the absolute and relative values of the development level and on the basis of counting the development dynamism in this way a certain type of order of micro-region can be created.

Order	Microregions	Development dynamism	Development dyn, related to the average	
1.	Gyöngyös	22.97	13.5	development dyn.
2.	Eger	6.50	3.8	considerably
3.	Leninváros	3.90	2.3	above average
4.	Sátoraljaújhely	2.14	1.3	devt. dyn. above average
5.	Salgótarján	1.14	0.62	devt. dyn
6.	Ózd	1.04	0.61	below average
7.	Miskolc	0.64	0.4	
	fictitious	1.70	1.00	

The order created by the development dynamism supports the changes which took place in the orders created by the development level.

The most important characteristic features of the development dynamism

1. There was no centre of average development intensity during the researchde period of time which proves the unequal development among the micro-regions.

2. Development dynamism above the average is shown by the centres which were undeveloped in 1965. Mention must be made of the Gyöngyös micro-region which became the most highly developed micro-region with an intensity which was 13.5 times above the average. In the case of Eger and Sátoraljaújhely micro-regions the development dynamism which was above average could not change the development quality of the micro-region.

3. The regions which showed development dynamism below average belonged to the most highly developed areas in 1965 which also proves the fact that the industrial development took place in the areas which used to be undeveloped.

4. The differentiated development of the micro-regions is proved by the fact that the proportional differences are very big in the case of the centres which showed

higher development dynamism than average while in the case of the other regions which belong to the other categories these differences can be neglected because they represent identical development with their factors.

To sum up it can be declared that the areal distribution of industry became more favourable in the researched period, although the size of the industrially undeveloped places is still considerably big and the industrial development increased the differences among the micro-centres parallel with changes in their order. (The ratio among the most developed and most undeveloped micro-regions was 37.3:1 in 1965, this became 37.4:1 in 1972 and the relative differences increased from 38.7:1 to 44.5:1.)

The structure of the industry is basically defined by the heavy industry as well as its branches on both macro- and micro-region level. The resource industries play a predominant role: their employment and technical factors are above the country-wide average. Naturally there are specialisations in the above-mentioned branches mainly in the micro-centres which belong to the traditional industrial agglomerations. It is very interesting that the micro-regions are outstanding because of one of their branches. Miskolc micro-region is an exception to this rule because its heavy industry has a proportional areal distribution within the micro-region and its role extends to the border of the micro-region. (See Fig. 1 and 2.)

According to the country-wide tendency a decrease in the weight of the heavy industry could be traced in the researched period in the north Hungarian macro-region (its size was the biggest in the resource industry), but this did not modify the specialisation tendency of the region. Although in the case of some micro-regions the structural shift towards light industry and food production was considerable they could not counterbalance the heavy industry. There was no specialisation in the light industry or in food production.

Researching the industrial structure in respect of the areal distribution the effect of the natural geographical factors can be noticed. Branches of food production become dense in settlings which are near the lowland while branches of heavy industry are in a strong connection with the local natural resources as well as the import-transporting roads. (See Fig. 3 and 4.) The branches which have nothing to do with natural resources, e.g. the textile industry, do not show areal concentration.

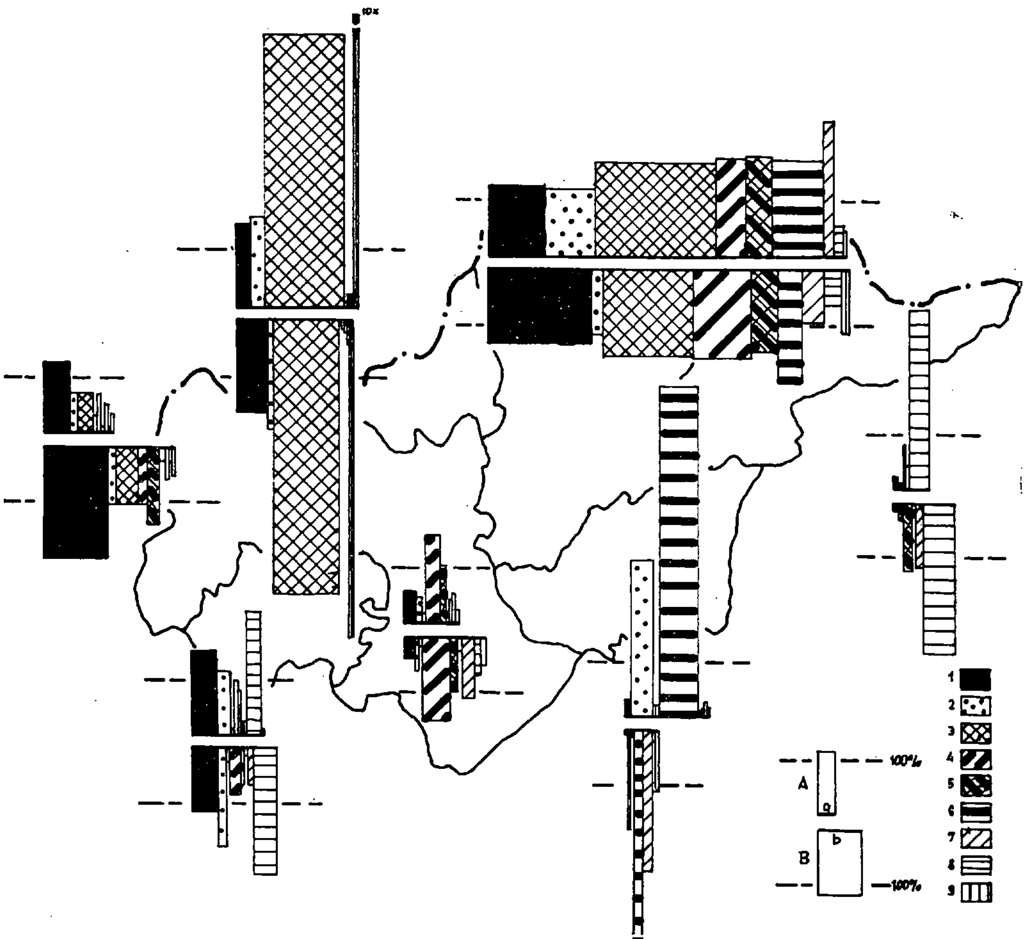

Fig. 1. Brutto value of investment stocks in the socialist industry and the distribution of the employment accordings to industrial branches in microregions (1965)

1 = mining
2 = electricity
3 = metallurgy
4 = machine-industry
5 = building material production
6 = chemical industry
7 = light industry
8 = food-production
9 = other branches

A = brutto value of investment stocks
B = number of employment
a = 1 md Ft
b = 10 000 people
100% = mezoregion average (for 1000 head)

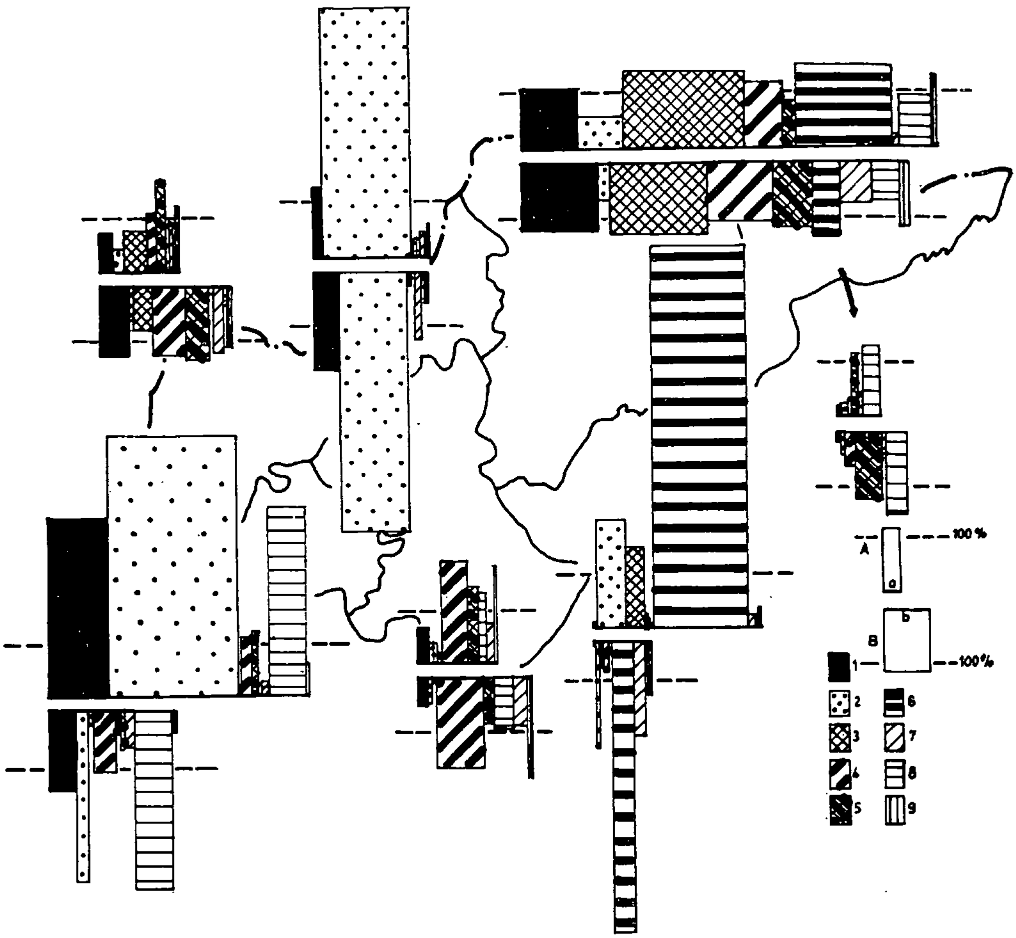

Fig. 2. Brutto value of investment stocks in the socialist industry and the distribution of the employment according to industrial branches in microregions (1972)

1 = mining
2 = electricity
3 = metallurgy
4 = machine-industry
5 = building material production
6 = chemical industry
7 = light industry
8 = food-production
9 = other branches

A = brutto value of investment stocks
B = number of employment
a = 1 md. Ft.
b = 10.000 people
100 % = mezoregion average (for 1000 head)

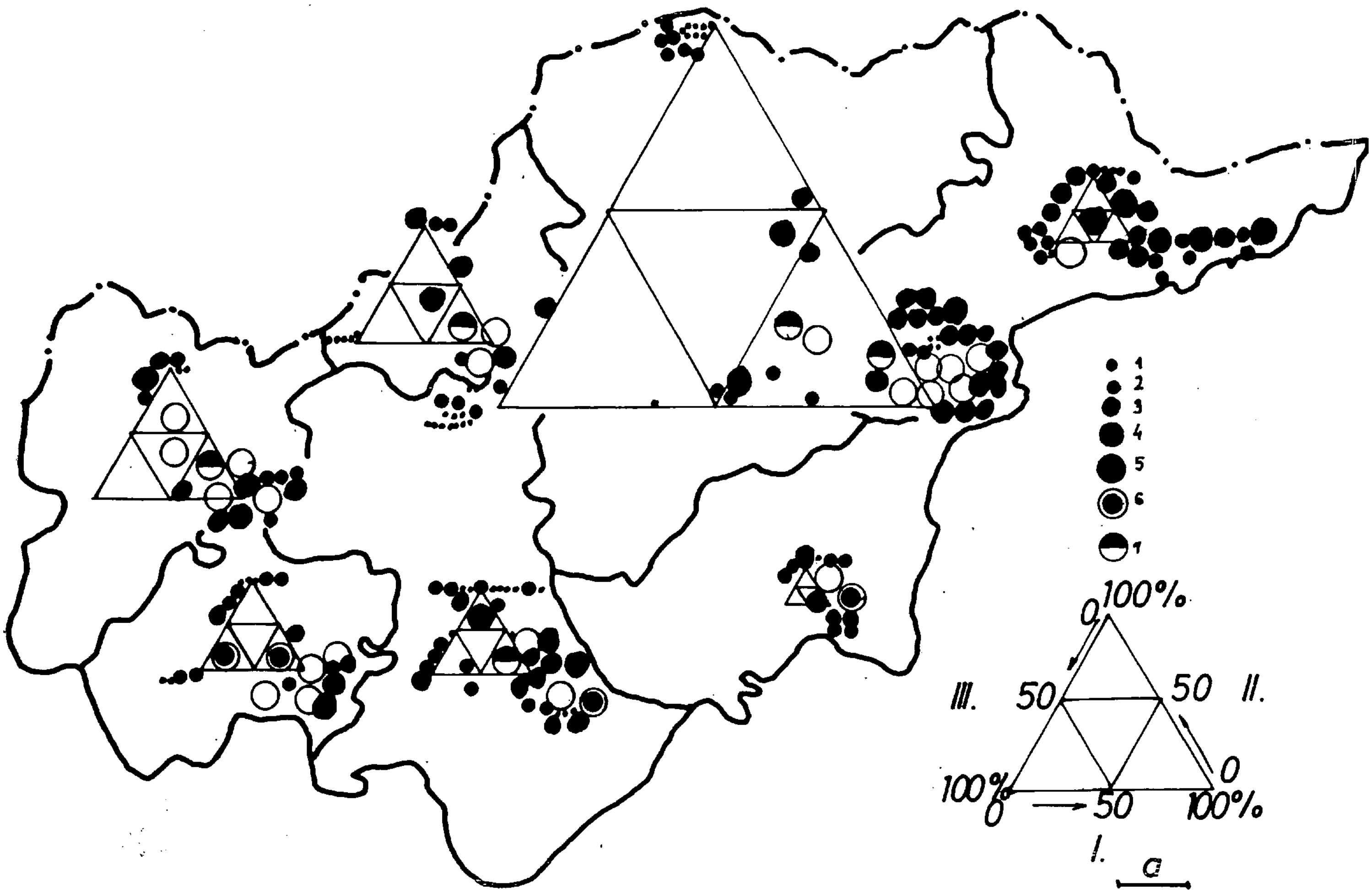

Fig. 3. Regional and branch structure of industry according to the number of employment in the microregion in North-Hungary (1965)

I = heavy industry	1 = < 10	people
II = light industry	2 = 11 – 100	people
III = food-production	3 = 101 — 500	people
a = 10.000 people	4 = 501 – 1000	people
	5 = 1001 – 5 000	people
	6 = 5001 – 10 000	people
	7 = > 10 000	people

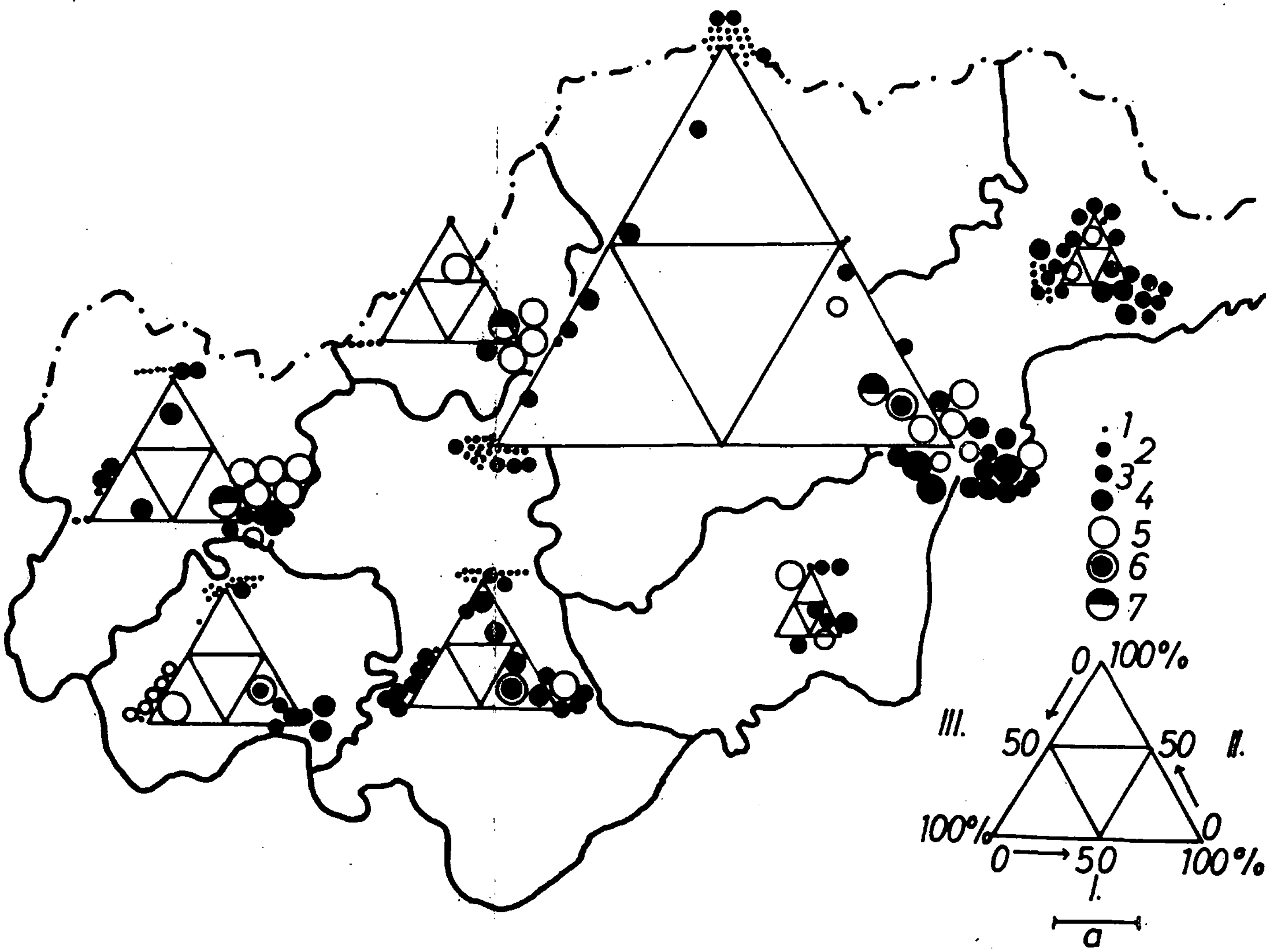

Fig. 4. Regional and branch structure of industry according to the number of employment in the microregion in North-Hungary (1972)

I = heavy industry	1 = <	10	people
II = light industry	2 = 11 –	100	people
III = food-production	3 = 101 –	500	people
a = 10 000 people	4 = 501 –	1 000	people
	5 = 1001 –	5 000	people
	6 = 5001 –	10 000	people
	7 = >	10 000	people

ATTEMPT AT DETAILED, COMPLEX AREAL-STRUCTURAL ANALYSIS OF MIGRATION

J. Tóth — L. Tánczos — Szabó

With the development of forces of production and of division of labour the spatiality of production undergoes changes, too. In respect of man as the main force of production this perpetual change is manifested in the migration of population. The migrating process of population can be looked upon as constant but it can increase during certain periods of development in the forces of production which cause considerable areal-structural changes. In these periods which can be characterised by an increased mobility of the population one can find socio-economical problems caused by the migration which make necessary research into this process as well as its collateral phenomena. During the course of migration centres of concentration and "population-releasing" areas are formed. A dynamic balance between these two poles is very important; this is the basic sine qua non of the undisturbed redistribution of the population which must be at a desirable rate in respect of the socio-economical side of population. To investigate the occasional temporary inbalance of the two poles and all the effects of this inbalance is therefore of special importance. To analyse the changes which take place in the two poles themselves caused by the migration course is important, too. These changes — although different in character — appear in both poles as demographical, economic, and infrastructural social problems. To investigate these research problems, one must know about the volume, trend, structure and areal connections of the migration course. The required, detailed and satisfactorily grouped data-basis must be provided by statistical data providing information. With all these data we can extend the inquiries into the migration process with regard to the areal settlement of the population, to the social composition in respect of age and sex in the given areal units, to the educational level and various communal and infra-structural degrees of supply. The migration process causes changes in each of the above-mentioned factors and we must extend our inquiries so that they will be effective. This effectiveness is demanded by the need for areal planning.

II.

In our country, as in all the other European socialist countries, the great socio-economical changes in the past three decades, the dynamic development of forces of production and the rapid transformation of the areal and sectorial structure of production increased the mobility of population, urbanization accelerated, and the inter- and intra-regional migration of the population increased immensely, too. The significance of this migration orientated the research itself and called forth publications of value both in theoretical and practical respects. Budapest — the result of the peculiar historical-economical development of our country — has a special place in the Hungarian settlement system and regional division of labour. During the last decades — in respect of rate and mainly the volume — Budapest had an outstanding role in the migration movement as the most important centre of concentration of the population. Therefore it is natural that inquiries into migration concentrate mainly on the capital. (e.g. PESTI L. 1969, KURUC A. 1971, V. TAJTI E. 1971.) Besides Budapest regional research concentrated on cities in the country which had been developing dynamically. The results of this research are differentiated by the fact that it made special efforts to discover particularly any specifically regional aspects of the migration process. (KOLTA J. 1968, TÓTH J.—KRAJKÓ GY.—PÉNZES I. 1969, CSÉPES J. 1974.) The country-wide migration movement as such — approaching the problem from different points of view — was analysed by a great number of scientists. The results are of basic value in respect of the tendency, the volume and the areal relationships and provide a basis for comparison of the regional research. (SÁRFALVI B. 1964, COMPTON P. 1968, V. TAJTI E. 1972, TÓTH J. 1973, SZAUTER E. 1974.) Commuting — which is related to the migration process, but again it can be separated from it because of its peculiar problems — has its own technical literature. From this technical literature we refer only to the part that concentrates on the city which we chose as the example of our research. (DÖVÉNYI Z.—SIMON I. 1974.) Among the above-mentioned studies and among the ones we were not able to mention owing to lack of space we did not find studies which either analysed the detailed structural and regional phenomena of the migration process, or concentrated on its complex structural-regional analysis. This comes from the inefficiency of detailing the statistical figures which register the process.

III.

The mobility of the population in our country — even though it is on a higher level than it was during the period between the two world wars — shows a decreasing tendency from the 1950's. The exponential trend chosen from the over one and a half decades long period (1955—1971) of constant mobility shows a 2% decrease per year. The situation is very similar in the case of temporary mobility, too. (SZAUTER E. 1974.) The trends of our country correspond closely with the trends in the other socialist countries in Europe. The global trend of the mobility, however, covers up certain specific aspects. Three of these are very important:

a) With the decreasing intensity of the mobility the rate of the inter- and intra-regional migration gradually changes in favour of the latter. The rate of moving about within a county increased by 3.2% between 1968 and 1971 (country-wide percentage rate). (SZAUTER E. 1974.)

b) The volume, direction and rates of migration are in close connection with the province and the hierarchical level of the settlements. With the increasing of the hierarchical level the significance of the migration difference grows greater in the population. (TÓTH J. 1973.)

c) One can see differences in the migration course in each area. In certain areas the mobility decreases, in other areas the mobility increases in comparison with the average mobility. The interests of the national economy as well as practical interests demand the division of the global average rates into components, and the discovering of the specific features of the migration course so that these data could be used in regional planning. Supplementing the insufficiency of statistical data by acquiring original data from the area we made an attempt — on the basis of the migration conditions in Békéscsaba in 1969—1973 — at a detailed, complex, areal-structural analysis of the migration course in that area. Without publishing the results in detail (TÁNCZOS—SZABÓ L. 1975) we give an account of the declarations and conclusions of methodological, theoretical and practical importance.

IV.

On the method of getting the necessary data, on the area from which the data was acquired, and about the methodological questions of processing the data we can declare as follows:

a) As the subject of our research we chose a middle-sized Hungarian settlement, Békéscsaba, which has sixty thousand inhabitants. There the data on migration are extensive enough for a detailed analysis but they do not go beyond a limit which would make it practically impossible to get the necessary data using the method mentioned above.

b) We got the necessary data by having registration forms filled in — this meant having six thousand forms filled in.

c) The data refer to the population over 14 which takes part in the migration process and contain the data about both permanent and temporary migration.

d) The data contain important pieces of information, i.e. answers given to the questionnaire on the registration forms such as:

"Where did you come from and where are you going to?"
"Age."
"Sex."
"Profession."
"Education."

So the basic number of items of information is about $5 \times 6{,}000 = 30{,}000$.

e) Data from five years (1969—1973) were processed, so — comparing the processed data with the relevant statistical data and estimating moderately — we can refer to certain tendencies of the migration course.

f) Data were gathered and processed so that during the structural analysis they could be compared with the data from the population census of 1970.

g) Owing to the lack of computer-capacity data were processed in the traditional — statistical, geographical and cartographical — way. Using computers for processing and storing the data, a detailed areal-structural analysis of the area could be done any time, very easily and very quickly.

V.

Before starting the structural analysis of the data referring to migration, we must make some general statements. In the first place we must say that, in contrast with the country-wide trend, migration is increasing in Békéscsaba. Apart from the pause in 1972 this increase is continuous and is at a considerable rate from year to year. The country-wide increasing rate of intra-regional migration is not compared with the moving population on a country-wide scale. In the case of the immigrant population the high percentage rate of people from Békés county is still increasing (the percentage rate of the immigrant population is 73.9% during the five years), but the similar percentage rate of the transmigrant population did not change considerably (from 1969 to 1973 it was 52.24%). The difference in the percentage rates shows that Békéscsaba has a certain gathering-selecting-passing role in the migration course. It is also very important that the migration margin of the town is positive and its tendency is increasing. On the structural analysis we can give the summary of the peculiar features of the migration course.

a) In contrast to expectations and the country-wide conditions the mobility of women is greater than that of men; the percentage rate of women in the whole population as far as mobility is concerned is 54.2%. But since the changes in the structure of production in towns and the new working opportunities increased the percentage rate of men — the percentage rate in the new difference of mobility in towns is higher in the case of men. So the migration course contributes to the balance of the breakdown by sex. (According to the population census of 1970 53.2% of the population over 14 is female.)

b) With the exception of the population over 60 the town has migration gain in every generation. The migration difference is the highest and shows an increasing tendency in the case of the youngest generation (people between the ages of 15 and 29 inclusive). The percentage rate of the young generation in the immigrant population is increasing. The distribution by age is that the immigrant population as a whole is younger than the transmigrant one and than the corresponding generations of the population in Békéscsaba. So we can say that the population in the town "gets younger" by the migration.

c) The town concentrates on workshops of a higher level of qualification than its surroundings and needs more skilled work-hands. According to education, the educational level of the immigrant population is higher than that of the transmigrant population and the corresponding generations in the population and the corresponding generations in the population of Békéscsaba. So the distribution by educational level of the population is developing in the town by the migration. The course is slow and there are problems, however. According to the data the town cannot provide work for people who did not complete at least 8 years of secondary schooling; their percentage within the immigrant population is decreasing — by 1973 it was only 1.2% (while in 1969 it was still 29.0%), — while their percentage rate, in spite of the decreasing percentage rate, is still considerable (1969: 21.2%, 1973: 11.6%). Since in the town there are no institutions of higher education, a section of the graduates from secondary schools leave Békéscsaba; as far as the secondary-school graduates are concerned, the migration gain of the town is not considerable. The concentration of university graduates shows a very weak tendency.

d) With reference to the quality of the employment as well as the professional conditions — according to the main tendency and the level of functional development of the town — the number of manual workers and that of the employees increased as a result of the migration in Békéscsaba. The concentrating power of the town for mental workers shows an increasing tendency. The migration loss which is very unfortunate in the case of students is rooted in the lack of institutions of higher education.

VI.

The analysis referring to the areal connections of the migration course was done in two approaches. The peculiarities can be summed up as follows:

a) The distribution according to towns and villages as well as settlings with a central role and settlings with no central function shows that while Békéscsaba has a considerable migration gain in contrast with the latter, the migration course in connection with towns and settlings with a central function leads to migration loss. It is important observe that the rate of the loss — although it is higher in connection with the bigger centres — corresponds to the hierarchic grades of the bigger centres contradictorily. The migration balance of the town is negative even in connection with the lowest researched level, i.e. with the settlings which belong to the partional medium centres, although Békéscsaba is to have a high place and important role in the hierarchy of the centres. On the detailed analysis we can form the conclusion that in the case of Békéscsaba it is the areal situation and the level of communal equipment rather than the hierarchic grade of settlings of central importance which influence the balance of the migration course. This statement is supported by the fact that apart from centres in Békés county the migration balance of Békéscsaba is positive in contrast to a lot of other centres in the lowland area.

b) Areal analysis was done according to economic-planning centres and counties, then — referring to the whole county — according to villages, too. In contrast to the central, North-Transdanubian, South-Transdanubian and North Hungarian economic-planning centres the town has — in corresponding order to the abovementioned areas — migration loss, while in contrast to the Northern Lowland it has a migration gain of a few people, and in contrast to the Southern Lowland one of nearly a thousand people. This gain is due to the migration gain of the town in contrast to Békés county, because the town has migration loss in contrast to the two other counties which belong to the centre, namely Bács-Kiskun and Csongrád. According to counties: apart from Békés, Békéscsaba has a migration gain of minimal value only in contrast with Szolnok and Hajdú-Bihar. The greatest proportion of the migration loss is in favour of Pest county rather than the other ones where the distribution of the transmigrant population is equal. The percentage rate of the migration loss related to the volume of the migration course is highest in the case of Komárom, Pest, Vas, Zala, Somogy and Baranya counties. Analysing the data of immigration and transmigration in the fullest detail we can assume that the migration of the population touching Békéscsaba is of the highest pitch in the areas which are near the border of Békés county, i.e. in certain areas of Csongrád, Szolnok, and Hajdú-Bihar, apart from the settlings within Békés county. In other parts of the country the number of the population spreading out from Békéscsaba decreases in proportion with the distance. The Veszprém—Budapest—Borsod axis can hardly be seen — and if it can, it is because of the towns. For the country and county maps of the migration difference see figures 1. and 2. Apart from Békés county, it is only one or two settlings near the border of Békés county that provide migration gain for Békéscsaba. The low values of the settlings which are far away from the town show the eventuality of the migration connection. We want to point out only one or two of the details. It is interesting, although explainable by the historical past as well as the present peculiarities of the functional distribution of work, that in contrast with the centre of the county Gyula has a positive migration difference. In another

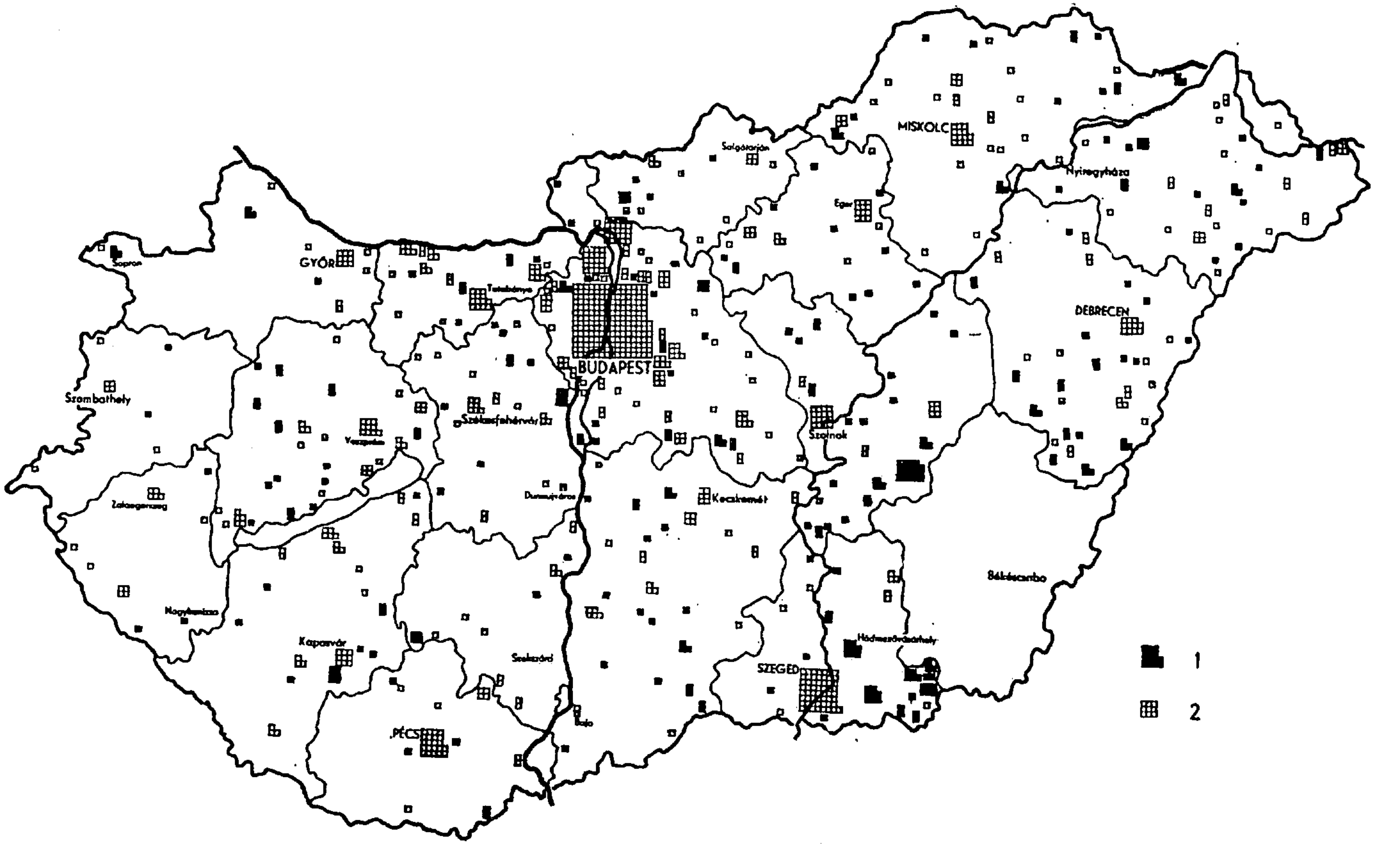

Figure 1. Migration difference relating to Békéscsaba (1969—1973 without Békés county).
1 = Migration gain
2 = Migration loss
(one square unit stands for 1 migrating person)

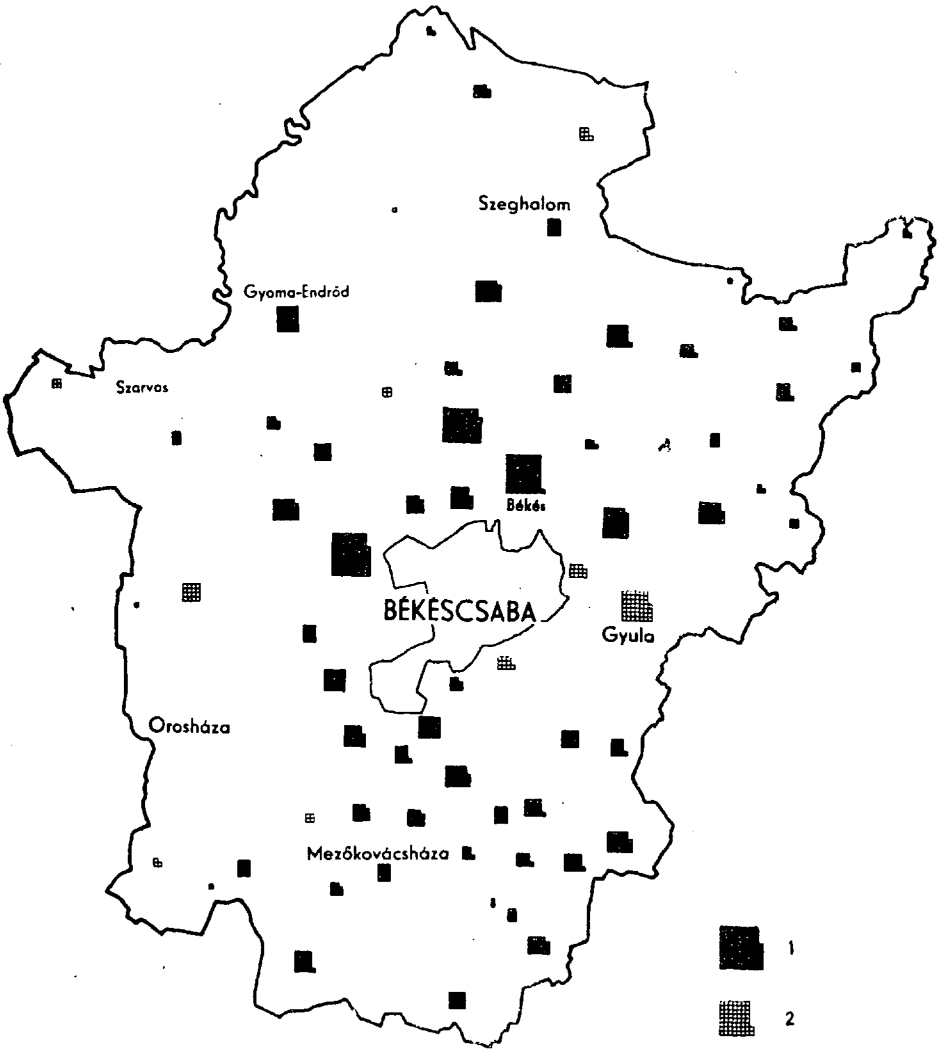

Figure 2. Migration difference relating to Békéscsaba (1969—1973 with Békés county included).
1= } see Fig. 1.
2=

respect it is remarkable that four villages in Csongrád county — Pitvaros, Csanádalberti, Ambrózfalva and Nagyér — have an important role in the migration to Békéscsaba. This phenomenon makes it certain that the national distribution of te population has a considerable role in the migration course.

VII.

All the structural criteria (distribution by education, by age, etc.) which were researched relating to the whole migration course in connection with Békéscsaba can bethe subject of a further analysis according to settling-levels and areas. On the basis of this further analysis the picture of the immigration and transmigration as well as their complex areal-structural outline could be obtained. We must point out the following data from the details of the peculiarities in the areal-structural part of the migration course in Békéscsaba:

a) On analysing the structural criteria of the immigrant and transmigrant population we can see that in contrast with the towns and settlings of central role Békéscsaba is not at a disadvantage only because the town has migration loss, but also because of the fact that it loses population of favourable structure and gains population of less favourable structure. The level of the loss is decreasing according to the hierarchic levels (with Budapest as the city of the highest hierarchic level).

b) The structural criteria of the migration course are favourable for Békéscsaba in contrast with settlings of no central importance; the town — besides the fact that it has a migration gain in this respect — gains a population of more favourable structure than that of the transmigrant population. The role of the villages in Békés county is essential in creating this situation; in the case of the villages in other parts of the country the structural difference is not great.

c) According to bigger areal units (economic-planning centres, counties) the structural conditions of the immigrant and transmigrant population follow the tendency of the migration difference. The positive migration difference of the areas such as the Southern Lowland area as well as Békés county modifies the structure of population in the town favourably, while the areas of negative migration difference such as Pest county and the majority of the centres modify the structure of population in the town unfavourably. The towns in Békés improve very little the structure of population in Békéscsaba while the villages in the county do so to a large extent. In this respect the county can undergo a further differentiation.

VIII.

On analysing the results of the research relating to Békéscsaba we can assume that the detailed, complex, areal-structural analysis of the migration points out a lot of special features and connections of the migration course which could be very important for the practice of planning-directing. It gives a detailed description of the complicated inter-relationship which exists between the different factors of the town, such as the role, infra-structural level, changes in function, and the volume of the migration, its tendency and structure. According to the factual results of the research the specific features of the migration course relating to Békéscsaba are as follows:

a) The trend of mobility which is different from the country-wide trend of mobility.

b) The greater mobility of women.

c) The majority of men in the migration difference.

d) An effect which improves the age-distribution of the population.

e) An effect which improves the educational level of the population.

f) Quality and quantity migration loss in contrast with the other settlings of central importance.

g) Quality and quantity migration loss in contrast with the great part of the economic-planning areas and counties of the country.

h) Great quality and quantity migration gain in Békés county.

i) The superiority of point *h)* in contrast with the other towns of the county.

On analysing the special features we can assume that Békéscsaba which has the most important position in the migration course of the county has a very moderate role in the country-wide course. Today the function of the town can be described as gathering, selecting, and passing on.

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